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1. MANAGEMENT

Gas Industry Management

Handbook of Natural Gas Engineering. D. L. Katz, D. Cornell, R. Kobayashi, F. H. Poettmann, J. A. Vary, J. R. Elenbaas and C. F. Weinaug. (New York: McGraw-Hill Book Co., Inc., 1959) 802 pp. $37.50.

Book treats natural gas in its various stages from occurrence in the reservoir through production, processing, and transportation to the ultimate consumer. Primary emphasis is given to the properties of the hydrocarbons and the application of these properties in flow and processing operations. Authors' intention was to present procedures for the conduct of enginering calculations for the design of equipment required to produce and deliver natural gas. Derivations and explanations of engineering principles governing the operations are included to provide background. A considerable amount of quantitative data in the form of charts, tables and formulas is presented to serve as a basis for design calculations.

The Industry's Biggest Headache . . . Rising Costs. *Am. Gas J. 186,* 26 (1959) May (2 pp.)

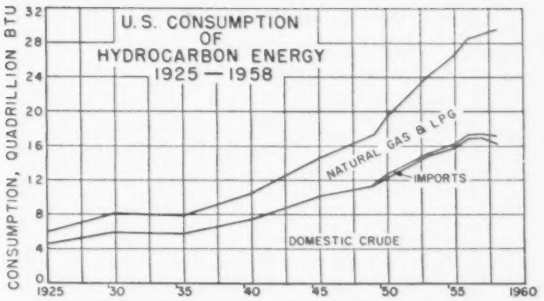
In today's spiraling economy, measures taken to save pennies are more likely to be needed to "keep up" than to add to earnings. In the gas distribution industry, at least, that seems to be the case. Article presents examples of what's happening . . . and suggestions — from gas distribution men around the country — on ways and means of reducing costs.

Cost of Service Approach to Pipeline Economics. F. V. Whitney. *Petrol. Eng. 31,* D-44 (1959) May (4 pp.)

Presentation of method used by El Paso Natural Gas Co., Texas. Actual format used for a study of the cost of service is described. One format describes plant type (compressor stations, etc.) studies; the other pipeline studies. Once this cost of service has been determined, it can be used to evaluate which of several methods is the most economical.

Sources of Grid Gas Supply in Wales. S. L. Wright. I.G.E. Communication No. 547. *Gas World 149,* 1037 (1959) May 30 (2 pp.); *Gas Times 93,* 41 (1959) May (2 pp.); *Gas J. 298,* 462 (1959) June 3 (2 pp.) **Discussion.** *Gas Times 93,* 61 (1959) May.

Author reviews availability of gas in Wales in relation to the development of demand and describes some of the problems and considerations that have attended the development of gas availability to meet an increased total annual demand of 37% since vesting day when 93 undertakings in Wales were operating gas-making plant producing 40 million therms of gas/yr. Author refers to the flexibility of operation of gas production plant, provision of plant and feedstock suitable for intermittent operation, and the internal use of gas for summertime power and heating requirements, with the three objects of 1) compliance with contractual obligations of purchased gas; 2) optimum degree of base-load operation for all concerned, and 3) ability to meet peak demands. An account is given of the progress made with schemes for utilization of methane drained from five coal mines in North and in South Wales.



(Data from *Natural Gas—Partner and Competitor.* See abstract, p. 181.)

Influence of Modern Techniques on the Domestic Gas Load. J. D. C. Woodall. I.G.E. Communication No. 546. *Gas Times 93,* 59 (1959) May; *Gas J. 298,* 440 (1959) June 3 (2 pp.) **Discussion.** *Gas Times 93,* 62 (1959) May (2 pp.)

Author first deals with the reasons for the decline in domestic consumers of gas since 1950-51. Since that date, consumption per domestic consumer has fallen from 124 therms to 109 therms/annum. Three main reasons are given: 1) Reduction of use of gas in domestic cookers; 2) government-inspired trading restrictions, and 3) competition from other fuels. In the second part of his presentation, author discusses various factors affecting the future development of the domestic load. Probability is that during the next two decades the greater part of the 40 million tons of solid fuel now burned in domestic premises will be replaced by more refined fuels—gas, oil or electricity.

PHOTOCOPIES

Gas Abstracts readers are requested to consult the inside back cover of this issue for a change in the procedure of ordering copies of articles, patents and books abstracted in this publication.

Gas Industry Expansion

Transwestern's California Line Hits Snag. *Oil Gas J. 57,* 163 (1959) May 18.

Transwestern Pipeline Co.'s bid to provide a new natural gas supply for Southern California has been opposed by the FPC. In a brief filed in May, a staff counsel recommended that the FPC deny a certificate for construction of the 1800-mile pipeline system proposed because 1) prices offered to producers of gas are at such levels as to be contrary to the public interest and 2) Transwestern's gas supply was not proved reasonably adequate to support the project.

The Vancouver Story. O. E. Zwanzig. *A.G.A. Monthly 41,* 7 (1959) May (4 pp.)

Account of phenomenal consumer acceptance of natural gas in an area where acceptance was once 'limited and waning.' Important factor in this change in attitude was completion of Westcoast Transmission Co.'s 600-mile pipeline in November, 1957. Westcoast system connects with Pacific Northwest Pipeline's system at the border, thus providing British Columbia Electric with a double-ended pipeline supply. Customer enthusiasm in Vancouver anticipated the actual arrival of the natural gas. During the middle of 1956, some 4600 homes installed gas furnaces. During that time, some were even supplied temporarily by the company with LPG. This gain of residential customers prior to the advent of the gas was remarkable for a company which, at the end of 1955, supplied fuel for domestic heating to only 1871 customers out of a total of 51,600 manufactured gas customers. More people then were using electricity for heating. By March 1, 1959, number of domestic gas heating accounts had grown from 1871 to 43,900. Total number of customers had increased to 86,000. As a result, British Columbia Electric now serves more customers than does any other gas company in the Pacific Northwest region.

Canadian Exports

Midwest May Get Canadian Gas Yet. *Petrol. Week 8,* 11 (1959) May 22 (2 pp.)

Obstacles holding back Canadian gas exports began to be cleared in May. First, Trans-Canada Pipelines, Ltd., applied for an export permit to deliver 200 MMCF/day of gas to Midwestern Gas Transmission Co. Since the Trans-Canada application, the Canadian Government has taken steps to create a National Energy Board to issue export, as well as import, permits for natural gas — a move that was recommended last fall by the Royal Commission on Energy.

Methane Liquefaction

Constock Looks at Pakistan. *Oil Gas J. 57,* 182 (1959) May 18.

Natural gas from West Pakistan's Sui field may become a source for tanker shipments of liquefied methane. Talks were held with officials of both the government and of Pakistan Petroleum, Ltd., which operates the field. Representatives of Constock after returning from a visit to Sui field, indicated cautious optimism about exporting the gas. Reserves are very large, and most of the requirements to make the project worthwhile are in existence. Constock sees Japan, Australia and South Africa as possible markets for Sui gas, if technical and economic problems can be worked out. Liquefaction project could be completed within two years if preliminary studies, planning and negotiations are completed quickly.

LPG Tanker

LPG Will Enter Worldwide Markets. *Petrol. Week 8,* 15 (1959) May 29 (2 pp.)

First special LPG vessel of tanker proportions, the 35,000-ton Esso Puerto Rico, is scheduled for delivery within 60 days. Currently it is undergoing final sea tests by its Trieste (Italy) shipbuilder, prior to delivery to Panama Transport Co., of the Standard Oil Co. (N. J.) group. Ship will be able to carry 75,000 bbl of LPG — about twice as much as the largest existing LPG-carrying vessels. Ship's owners have already scheduled the vessel for Venezuela-to-East Coast service.

Petroleum

U.S. Contractors Combine Methods, Arab Labor to Build Port in Mid-East. *Construction Methods and Equipment 41,* 157 (1959) May (10 pp.)

One of the world's biggest prestressed concrete plants is smoothly turning out 5300 piles and 370,000 sq ft of deck slab for a major harbor development in Kuwait on the Persian Gulf. The setup combines the most advanced U.S. know-how with centuries-old Arab methods.

Well Costs Continue to Skyrocket. *Oil Gas J. 57,* 89 (1959) June 1 (3 pp.) **Domestic Drilling Costs Jump 80 Cents per Foot.** *Drilling 20,* 74 (1959) June (2 pp.)

Special report on drilling costs, the second ever compiled, was conducted by the API, the IPAA and the Mid-Continent Oil & Gas Association and was based on 1955 and 1956 data. Study briefly showed: Average cost per producing well rose from $51,900 in 1955 to $55,600 in 1956; average cost per dry hole also rose from $37,300 in 1955 to $41,600 in 1956; average per-well cost went up from $46,500

to $50,200 in the same period, and cost per foot rose in all categories. Higher costs are attributed to increased offshore activity, deeper holes and higher prices.

Research

Pipeline Research—Pacesetter for Growth. D. C. Benson. New York: A.G.A. Operating Section Proceedings; Paper No. GSTS-59-3; (1959) May; **Research in the Gas Industry.** *Gas Age 123,* 36 (1959) June 11 (2 pp.)

Report of A.G.A.'s Pipeline Research Committee whose activities are supported exclusively by pipeline companies and those companies having pipeline operations. Outstanding accomplishments of current program include: 1) publication of Vol. II on a series of production studies; 2) publication of the Branch Connections Summary Report; 3) field evaluation of gas cleaners; 4) development of radioactive tracer techniques for flow rate determination; 5) evaluation of the materials used for internal coating of pipe; 6) determination of wear in main compressor engines by lubrication oil analysis; 7) confirmation of measurement error due to pulsating gas flow; 8) determination of the effects of defects in line pipe on cleavage fracture and 9) successful completion of regulator station, noise abatement studies.

Research Programme of the French Gas Industry. R. Delsol and A. Renauldon. I.G.E. Communication No. 542. *Gas World 149,* 1028 (1959) May 30 (6 pp.); *Gas Times 93,* 52 (1959) May (2 pp.); *Gas J. 298,* 439 (1959) June 3. **Discussion.** *Gas Times 93,* 60 (1959) May.

Concise account of technical problems arising in the French gas industry as a result of its development, which is primarily the result of the economic position, availability of raw materials and new sources of energy. Solutions for these problems in the various fields of activity of the gas industry are determined by the Department of Gaz de France for Research and Testing of New Techniques. The Gaz de France Research Department has the task of studying, testing and developing new techniques, of predicting in advance the problems likely to arise, in order to solve them in good time, and, in short, of directing the technical development of the industry along progressive paths. Article gives a rapid survey of the work of this research department, of the results already achieved, and of those still to be obtained.

Can You Rate Your Research? *Chem. Week 84,* 35 (1959) May 30 (12 pp.)

Statistics indicate that 1) companies that spend a relatively large percentage of their sales dollar on research expect new products to bulk big in their future sales statements; 2) by and large, these same companies are growing faster than companies that do not pay much attention to research. Such a broad statistical approach demonstrates the general value of research, but it is of little help in evaluating a company's research program. Total U.S. industrial research expenditure in 1959 will total $7.2 billion or 2% of the gross national product. That is equal to total U.S. research expenditures from 1776 to 1940. Article points out that measuring research profitability is hazardous and describes three-phase program being conducted for the National Science Foundation by Case Institute (Cleveland) to 1) develop an analytical model explaining how the performance of a firm is affected by its research and development activity; 2) extend this theory to an industry (chemical industry is the target) and 3) extend these methods to the national economy, seeking to uncover ways that research and development activities in one industry affect — and are affected by — those of others.

Petrochemicals

Petrochemical Growth Faces Slow-Up. *Oil Gas J. 57,* 126 (1959) June 8 (2 pp.)

Petrochemical industry can expect an annual increase in demand of about 6% in the next five years. This estimate contrasts sharply with a demand growth rate over the last 10 years of nearly 11%, and a general chemical industry rate of 8%. Chief explanation: Market maturity. As production of individual chemicals has caught up with demand, the initial market surges have been arrested. Methane chemicals will increase by at least 3.1 billion lb/yr to an annual production of about 12.6 billion lb. Growth rate will drop from 13.4% to 4 or 5%. Ethylene-derived chemicals will rise by 3.5 billion lb/yr to an annual output of 9.7 billion lb. It is doubtful that this group will maintain its 12% yearly growth. Propylene chemicals will increase by 760 million lbs yearly to an annual output of 2.6 billion lb. These should have an over-all 5-6% annual growth rate. Butylene chemicals will grow by 900 million lb/yr to 3.2 billion lb. Current annual growth rate of 8.5% will not be maintained unless new products are developed. Outlook for butylene chemicals is 5-6%/yr growth.

Sulfur

Changing World Sulfur Balance. W.Haynes. *Chem. Week 84,* 107 (1959) May 16 (14 pp.)

During 1959, world sulfur supply will have increased by approximately 750,000 long tons. Most of this new production is not U.S. Frasch sulfur but, rather, elemental sulfur recovered from Canadian

and French sour gas. Next year, the output of the Societe Nationale des Petroles d'Aquitaine (S.N.P.A.) will approximately double (1960 total: 650,000 tons). In Canada, two new sulfur recovery plants are under construction, five others are in the blueprint stage. If all seven plants come onstream, Canada's sulfur producing capacity will grow by 595,650 tons/yr. Canadian output in 1960 will total 880,000 tons. World sulfur consumption in 1958 was an estimated 7.713 million long tons; it is estimated that it will be 24 million long tons by 1965. In 1954, the U.S. accounted for about 85.6% of world sulfur production; Mexico, 1.5%; Canada 0.3%; France, 0.1%; others, 12.5%. By last year, the pattern had shifted in favor of Mexico, Canada and France, as follows: U.S., 66.6%; Mexico, 15.8%; Canada, 2.5% France, 1.7%; others, 13.4%.

Customer Service

A Guide to Training Servicemen. Part 1. Gas Ranges and Basic Electricity. R. D. Montgomery. *Gas. 35,* 68 (1959) May (4 pp.); **Part 2. Conducting a Comprehensive Service Training Program.** H. C. Foote. *Ibid.,* 76 (1959) June (6 pp.)

In Part 1 the service policy of Citizens Gas & Coke Utility, Indianapolis, Ind., is described and an outline of the twofold training program, launched in 1956, is given. The first part of the program consists of a standard training curriculum composed of seven courses; the second part supplements the standard curriculum with special classes, field training, service literature, laboratory testing and a central reference library available to all servicemen. Author of Part 2 describes the overall customer service training program of one of the nation's largest distribution companies, Southern California Gas Co., Los Angeles. Article explains the reasons for the courses, and offers some concrete training advice to utilities of all sizes.

Exploration

Geophysical Work Drops 7.7% in '58. *Oil Gas J. 57,* 118 (1959) June 8 (2 pp.)

Although worldwide geophysical activity declined in 1958 by 7.7%, there were some bright spots in the picture: Western Hemisphere — activity in all geophysical methods declined because sizable reductions in the U.S. and Canada offset good gains reported from South America; Eastern Hemisphere — over-all activity showed a net increase with electrical prospecting methods especially showing up well; Soviet Russia — unconfirmed reports say geophysical activity increased substantially.

Education

The Utilities' Stake in Education. J. D. Garwood. *Public Util. Fortnightly 63,* 809 (1959) June 4 (11 pp.)

Somehow this country's teachers of economics and, through them, the students, must be led out of the classroom into the business shop and market place where they can see for themselves the mechanisms in action. Direct contact and educational contribution may be the opening wedge for impressing on the economics teacher the over-all view of the national economy instead of the poor little blackboard puzzles that illustrate theories of doubtful practical relevancy. Economic courses need a reorientation, oriented to the facts of life as they occur at the mid-century marker; i.e., an economic system composed of groups which have evolved into units which look to the government for direction, rules of the game, and succor in times of stress. This is markedly different from the structure of the economy at the turn of the century.

Heat Pumps

Predicting Annual Heating Costs of Residential Heat Pumps. S. F. Gilman and W. Clausen. *ASHRAE J. 1,* 52 (1959) May (6 pp.)

Annual sales of residential heat pumps using outdoor air as the heat source, and the number of companies manufacturing them, have increased considerably during the past few years. Although methods are available for estimating operation costs of residential cooling equipment and of heating systems using coal, gas and oil, there is no authoritative procedure to estimate annual heating costs of heat pumps. As a result, manufacturers have devised their own methods to provide reasonably accurate estimates. One method developed is described.

Gaslights

Gas Lights for 1959. *Gas Ind. 3,* 9 (1959) June (22 pp.)

Descriptive catalog of gaslights, a growing industry market, and their manufacturers is given. Brief history of the origin and evolution of gaslights is included.

Public Relations

What's Wrong with Public Relations? K. I. Jack. *Public Util. Fortnightly 63,* 889 (1959) June 18 (12 pp.)

Utility industry suffers from indecision and lack of planned, concerted action on the public relations front, author asserts. It needs seriously to appraise the admonitions of the many public relation practitioners who advocate expenditure of large sums of

money from which nebulous or hard-to-measure results are obtained. It should find out what problems are of the deepest concern to its consumers and align its interests with theirs in a way that counts. This means a positive, cooperative attitude on the part of management and, perhaps, the assistance of professional counselors in reviewing and analyzing steps toward practical public relations effort.

2. ENERGY AND SUPPLY ECONOMICS

Energy Sources

Natural Gas — Partner and Competitor. W. B. Davis and J. L. Schweizer. *J. Petrol. Tech. 11,* 13 (1959) May (6 pp.)

While producers look upon natural gas as a source of added income, it is also a direct competitor to products of crude oil at the consumer level. The growth rate of natural gas consumption has been greater than that of crude oil and can be attributed mainly to the lower price per unit of energy for which gas is sold. Increase in consumption of natural gas has had as great an impact on the domestic producer as have crude oil imports. Lower price of natural gas and its increased use have had the net effect of keeping the average wellhead price of hydrocarbon energy at approximately the same level for the past 30 years. Therefore, it appears that many of the domestic producer's troubles today are caused not so much by the fact that he is selling two competing forms of energy, but that he is forced to sell one, natural gas, below its true market value because of artificially depressed prices. Best remedy for this situation lies in the freeing of natural gas prices from control and allowing them to compete in the open market. Every domestic producer of crude oil has a big stake in the solution of this problem whether he sells gas or not, since his oil is forced to compete with the underpriced gas for a portion of the energy market.

A Statistical Analysis of Future Energy Consumption in the U.S. (1959-1965). J. Melnick. *Oil Gas J. 57,* 146 (1959) May 25 (7 pp.)

Obvious relationship between energy consumption and economic well-being in the U.S. is indisputable. It is only necessary to point to the use of energy in fostering increases in productivity to understand its impact upon the level of national output. Steady rise in energy consumption will occur despite the advances that are likely to be made in the efficiency with which energy is used. Innovations and changes in the design of energy-consuming units which will undoubtedly appear will make for more effective use of energy, thus raising the energy-efficiency factor. However, an adequate, dependable and continuous indigenous supply of energy will be possible only in an understanding and flexible "political" environment. Article makes no provision for a commercially practicable nuclear power supply for the period under review. Progress in this direction by 1965 will likely be small in comparison with the contribution of existing primary sources of energy. Purpose of article is to estimate the energy requirements necessary to meeting the growing needs of the American economy through the year 1965.

Gas Reserves

Development and Evalution of Gas-Condensate Reservoirs. W. C. Goodson. Part 1. *Petrol. Eng. 31,* B-97 (1959) Apr. (4 pp.); Part 2. *Ibid.,* B-66 (1959) May (3 pp.)

New fundamental series on gas-condensate reservoirs presents a complete history of operations from the time of leasing through development and economic depletion. Special emphasis is placed on how to obtain the best gas contract and a comprehensive valuation of all economic factors to predict as accurately as possible how much profit will be made. Part 1 discusses some of the important considerations for gas contractual negotiations from both the standpoint of the producer and from the standpoint of the purchaser or transmission company. A series of evaluations is developed and a basic curve constructed that would allow the management group to make their decision from the pertinent data only and not be burdened with the rigorous calculations involved in the evaluation procedure. Part 2 points out that after the productive limits of the reservoir have been determined and the formation evaluation has been defined, an initial in-place reserve estimate can be determined. Examples of reserve calculations and determination of gross value of recoverable reserves are presented.

Natural Gas — Canada's Prodigal. F. K. Beach. *World Petrol. 30,* 50 (1959) May (6 pp.)

Major reserves of natural gas in Canada are in the West, with Alberta having present proved reserves of 23.8 trillion CF, and Saskatchewan 1.16 trillion. In eastern Canada, Ontario reserves have been estimated at 187 billion. General review paper discusses natural gas in Canada in terms of outlets, price, the Borden Commission, byproducts, LPG producers, petrochemicals, sulfur and potash.

Petroleum Reserves

How USSR Has Doubled Production in the Past 5 Years. A. P. Krylov et al. *Oil Gas J. 57,* 150 (1959) June 8 (4 pp.)

Success achieved in prospecting and developing oil

fields in the USSR has made it possible to set the goal of raising oil production up to 350-400 million tons/yr in the next 15 years. Well productivity has been increased by 1) optimum distribution of wells throughout the field; 2) different schemes of water injection, using peripheral, perimeter and intracontour flooding; 3) increasing the pressure in the water-injection wells; 4) decreasing bottom-hole pressure at the producing wells, and 5) reducing the skin effect. Wider well spacing and hydraulic fracturing also have been incorporated in the Soviet's drive toward a goal of 8,000,000 bbl/day by 1975.

French Push Oil Development of Fields in the Paris Basin. P. E. Swain. *Oil Gas J. 57,* 82 (1959) May 11 (2 pp.)

Petrorep, a subsidiary of Petrofrance, made the first commercial discovery in the Paris basin last year. Today the field has 22 wells drilled into the Middle Jurassic Dogger limestone found below 6100 ft. Seventeen of them are producers and four more are in the completion stage. Actually, Petrorep has found two, and possibly three, separate domes. Each trends southwest-northeast. The first discovery in February 1958 was on the southeast of the first of these. This well is now on pump. Those drilled near the top of the structure are flowing wells.

Canada's Exploration — 1958. C. A. S. Bulmer. *World Petrol. 30,* 58 (1959) May (5 pp.)

During 1958, a total of 2433 exploration and development wells were completed in western Canada, a decrease of 568, or 19%, from 1957. Alberta accounted for 60% of the total number of wells drilled, Saskatchewan 32%, Manitoba 4%, northeastern British Columbia 3%, and the Northwest Territories and Yukon Territory less than 1%.

Petroleum

World Output Hits New All-Time High. *Oil Gas J. 57,* 132 (1959) June 8.

Free-world crude production in March was at a record high for the fifth consecutive month. Increase resulted from another peak month in the Middle East, where output passed 4.6 million bbl/day. Western Hemisphere operators produced 4.2 million bbl/day, about the same amount of crude as in February. Russia claims production of 29.8 million metric tons the first quarter equal to about 2,420,000 bbl/day.

Economists are Optimistic about Oil's Future. *Oil Gas J. 57,* 98 (1959) June 8 (4 pp.)

By 1975, oil will supply 39% of all world energy (today it supplies one-third). Together with natural gas, it will supply 73%. This means a steady net gain in global use of oil. In detail, the pattern involves mixed factors dealing with cost, national policies and logistics. For example, world energy needs will increase 127% between 1955 and 1975; oil requirements to meet more of these needs will nearly treble in that period, increasing 187%; natural gas will make even further inroads at the expense of other fuels, including oil in some areas. Consumption in 1975 is estimated to reach three times the demand of 1955. Greatest single market for oil will remain in North America, even in 1975. Growth rate, however, will be higher on other continents as play for new oil reserves continues to move abroad.

Aramco Is Developing Northern Fields. P. E. Swain. *Oil Gas J. 57,* 129 (1959) June 8 (2 pp.)

Saudi Arabia will add its sixth producing field to the roster before the end of 1959 when the 3-year-old 5-well field at Khursaniyah goes on production. Initial output from this field will be about 45,000 bbl/day. This gives Aramco an additional supply of at least 250,000 bbl/day from the relatively new northern fields. This northern potential crude supply is entirely separate from the fields in the south where the 160-mile long Ghawar trend and Abqaiq (35 miles long) are still growing. Khursaniyah is the second of three fields in a northern tier of development both offshore (the Safaniya field) and on land. Six producers have been drilled so far at Khursaniyah and a seventh is underway. Offshore field at Safaniya has 32 wells, but is producing only a fraction of its potential from 19 wells. This is about 38,000 bbl/day.

Fact Book Issue. *Nat. Petrol. News 51,* Mid-May 1959.

Entire issue is devoted to statistics and data and is divided into three major sections: Company operations, market facts and directories. The first section includes annual reports-capital expenditures, Canadian companies and U.S. companies. Market facts are divided into the following categories: Automotive, bulk plants and terminals, Canadian, farm trade, fuel oil, gasoline, highways, LPG, lubrication, prices, retail market, supply and demand, taxes, tires-batteries-accessories and transportation. The directory includes associations — key names and addresses, water terminals in three main areas, legal issues, equipment jobbers, refineries, equipment directory and a tires-batteries-accessories directory and buyers' guide.

Underground Storage

Summary of Eighth Annual Report on Underground Gas Storage Statistics. L. R. Kirk. New York: A.G.A. Operating Section Proceedings; Paper No. GSTS-59-10 (1959) May; **$650 Million Spent on**

Gas Storage. A.G.A. *Monthly 41,* 10 (1959) May (2 pp.)

It was estimated that total capital investment in storage facilities and cushion gas is in excess of $650 million. Comparing 1957 with 1958, all storage totals showed increases as follows (all volumes in billion CF): native gas in storage reservoirs from 375 to 387; cushion gas from 627 to 670, and working gas from 673 to 608. Total volume of stored gas (excluding native gas) moved ahead from 1300 billion CF to 1377 billion CF; native gas increased from 1674 to 1764 billion CF.

New Projects Give U.S. Gas Storage Big Boost. R. B. Bizal. *Oil Gas J. 57,* 95 (1959) May 11 (6 pp); **Industry Continues to Go Underground for Gas Storage.** *Gas Age 123,* 43 (1959) May 14 (8 pp.)

Capacity is due to climb about 9.4% as companies pour millions of dollars into at least 18 new projects. This may boost nation's working-gas capacity to an estimated 1.45 trillion CF. Survey for 1959 shows that 53 companies have 207 projects in operation or planned in 21 states. Article includes breakdown by states of companies, working-gas capacity, cushion gas requirements and total capacity of reservoir.

The Economics of Underground Storage. H. L. Fruechtenicht. *Gas Age 123,* 34 (1959) May 14 (3 pp.)

Over-all job of supplying gas service to more consumers at an economical rate is to a large extent dependent on the use of underground storage reservoirs. Author discusses the important factors relating to underground storage, including transmission vs storage costs, role played by stored gas in meeting peak day loads, and a plea for a more equitable rate differential for reservoir operators.

Coal

Report on Stockpiling — 1959. R. A. Collinge. *Coal Utilization 13,* 18 (1959) May (3 pp.)

At the end of 1958, coal in stockpiles stood at 76.3 million tons; coal production during the year amounted to 402 million tons, and coal consumption for the same period was only about 415 million tons. At the end of 1957, the nation's stockpile of coal contained 80.8 million tons — just a few decimal points away from the all-time high. The coal industry had finished a year in which 493 million tons were produced and 490 million tons were consumed. One year later the picture had changed in every respect because of the impact of the recession on demands for coal. The drawdown is indicative of the beginning of a change — a recovery trend in recent months is evident, and the possibility of an end to a 17-year period of gradual buildup of stocks.

Space Heating

Electric Heating for an Elementary School. *Air Conditioning, Heating and Ventilating 56,* 70 (1959) June (2 pp.)

First school in Pennsylvania to be heated entirely by electricity, the Locust Grove Elementary School, Windsor Township, is a six-room building which houses 180 students. It was occupied for the first school term this winter. Estimated cost for heating from October, 1958, to March 1959, was $1540; actual cost for this period was $1574.

Heat Transfer

The Heat Balance of the Earth's Surface. M. I. Budyko. Washington: OTS (PB 131692) 1958. 259 pp. $4. (From *Appl. Mech. Rev. 12,* 368 (1959) May.)

Summary investigation is made in this treatise of worldwide climatological variations of heat balance and radiation balance components for both land and water surfaces. Annual and diurnal variations of such factors as radiational, turbulent and evaporative heat flux, total shortwave incoming radiation, effective outgoing longwave radiation and horizontal heat transport in the ocean are presented for various typical climatic regimes. Using heat balance and radiation balance components, water balance computations are made from which such significant hydrological and agricultural parameters as potential and actual evaporation, rainfall-runoff ratios and soil moisture transpiration are evaluated. These results are then discussed in terms of the effectiveness of such land preservation methods as irrigation and construction of shelter belts as well as reservoir design and performance forecasting.

J. R. Gerhardt, USA

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

Jet Deflection . . . A Recent Advancement in Directional Drilling. R. P. Dwyer. *Petrol. Eng. 31,* B-77 (1959) May (3 pp.); **Jet-Bit Deflection Saves Money in Directional Wells.** *Oil Gas J. 57,* 172 (1959) June 1 (3 pp.)

Jet deflection was developed to eliminate time-consuming practices of using more conventional tools. A conventional jet bit is used with all but one jet restricted, and this one jet of as large a diameter as the hydraulic system will permit. By eroding the well bore on the side and bottom in which the large

orifice is oriented, the bit tends to deflect in that direction. After the proper course is established, the same bit is used to drill ahead. Only conventional bits have been used, with variations in the jets. However, it is believed that the range of usefulness of this method can be extended by the development of special bits and tools more adaptable to jet deflection.

A Laboratory Study of Rock Breakage by Rotary Drilling. W. H. Somerton. *J. Petrol. Tech. 11,* (T.P. 8061) 92 (1959) May (6 pp.)

Effects of drilling variable on rotary drilling rates and efficiencies have been investigated in a series of laboratory drilling tests. Efficiency of rotary drilling as a rock breakage mechanism was extremely low. Comparison was made with theoretical energy requirements for size reduction by comminution methods.

New Type Drilling Tool Now on Market. *Petrol. Week 8,* 24 (1959) May 22 (2 pp.)

New rotary-drill consists of a short tubular case containing a hammer — the only movable part — an arrangement of stationary valves, and an anvil. Operation also is simple. While the hammer is the only part designed to move, the anvil "gives" a few thousandths of an inch each time it is struck by the hammer. As the bit rotates on bottom, gas or compressed air — pumped down the drillstem as the circulating medium — passes through a stationary valving arrangement which lifts the hammer and then drives it down on the anvil with considerable force.

Plastics Reduce Sand Problems along the Gulf Coast. J. A. Harmon and J. O. Hendrick. *World Oil 148,* 183 (1959) May (5 pp.)

Sand consolidation plastic has proven to be an effective remedy for unconsolidated sand problems in the Gulf Coast area. Most application difficulties have been eliminated and, for the type of treatments described in the article, the success ratio has been obtained by observing proper precautions during well perforating operations.

Russians Tell What's New in Drilling. *Oil Gas J. 57,* 104 (1959) June 8 (2 pp.); **How Russians "Drill" with Explosives.** *Petrol. Week 8,* 23 (1959) June 5 (2 pp.)

Russians have not only improved their turbodrill, but they are developing entirely new methods of drilling a well. Holes have been drilled with an electrodrill where the bit is driven by a down-hole electric motor powered by a cable inside the pipe and with a wire-line electrodrill where the fluid is circulated by down-hole motor and the cuttings are removed only periodically. They are field-testing a vibrating bit on the end of a conventional drill string; their newest development is bypassing bearings in the drilling bit. Biggest thing, however, is still the turbodrill. Of special interest is the Soviet explosion drilling method which consists of making hole by blasting special explosive charges in a liquid column. The charges are run at a predetermined rate into the drill pipe by the flow of the drilling fluid. The charges explode at the same, controlled rate on bottom. Russians claim the explosion method has been proved in field tests at depths to 9000 ft. Maximum continuous well interval drilled in hard formations is 1000 ft; maximum rate of penetration in hard limestones and dolomite is about 50 ft/hr.

We're Still Learning About Air and Gas Drilling. L. W. Randerson. *Oil Gas J. 57,* 142 (1959) June 8 (4 pp.)

Use of compressed air or gas as a drilling fluid is no longer experimental. But there is much to learn before full utilization of this technique can be realized. Author writes about gas drilling and concludes that 1) gas drilling is limited to operations in which the well bore is essentially free of liquids, an influx of 3 gpm being the upper limit; 2) since the wall of the hole is essentially unsupported, gas drilling cannot be used unless the formations are competent; 3) high pressures or large volumes necessitating control obviate gas drilling from both an economic and a safety standpoint; 4) since formational pressures in commercial producing horizons are greater than the hydrostatic head of the gas column, no formation damage from this fluid would be expected, and 5) because gas drilling is usually more costly than mud drilling on a unit of time basis, savings by reduction of lost time, improved penetration rates or reduced damage to the producing formation are necessary to justify gas drilling.

Drilling Muds

Drilling Fluids: Tiny Particles with Long Names Solve Big Problems Down Hole. R. O. Frederick. *Drilling 20,* 55 (1959) May (7 pp.)

By the 1930's many of the basic principals which underlie today's U.S.-Canadian consumption of approximately 1,200,000 tons of barite and 550,000 tons of bentonite a year had been established, a major factor in the $180 million annual expenditure for mud materials and chemicals. Much remained to be learned about *p*H (the hydrogen ion concentration denoting alkalinity or acidity of the fluid), electrolytes and other facets of mud composition. With improved knowledege of mud engineering came commercial availability of products tailored to virtually every drilling need. For salt water muds, attapulgite

clay in place of bentonitic clay; for filtrate loss reduction, as a suspending agent for weight material, as an emulsifier, and as an ingredient of low solids muds, sodium carboxymethylcellulose; for thinning muds through opposition to get structure development, natural tannins, lignins and lignosulfonates; for drilling mud weights as high as 22 lb/gal and killing fluid weights as high as 32 lb/gal, improved barites and other weighting materials with specific gravities as high as 7.0; for improved lubricating qualities, graphite and new extreme pressure lubricants. Article includes four-page table on drilling muds and additives, giving trade name and classification, product and/or application and from whom it is available.

Exploration

Exploration Tomorrow . . . and Beyond. A. I. Levorsen. *Oil Gas J. 57,* 138 (1959) June 8.

Article attempts to look into the future and predict those techniques, concepts and factors that will most likely guide and control petroleum exploration beyond the 1960's. Predictions are based on the assumption of an extension of the present economic and scientific environment.

A Geological Appraisal of Present and Future Exploration Techniques on Salt Domes of the Gulf Region of the U.S. M. T. Halbouty and G. C. Hardin, Jr. *Oil Gas J. 57,* 134 (1959) June 8 (4 pp.)

Present exploration techniques are based on analyzing all of the available geological and geophysical data and arriving at a reasonable interpretation of the geological history to be explored. Methods involved require considerable time and expense, but, in the opinion of the writers, are worth it. Combination of new geological and engineering concepts will govern the future exploration of salt domes. Successful exploration will depend on the geologist, geophysicist, micropaleontologist and petroleum engineer working as a team. Deeper drilling will be the keynote for testing the outer flanks and engineering factors pertinent to such deep holes will determine the depths of these wells. Constant revision of maps and cross sections and the preparation of elaborate three-dimensional diagrams are necessary to determine the interrelation of structure and sedimentation in the subjects area, and to determine the distribution of the faults, the extent of unconformities and the location of stratigraphic traps. More thorough understanding of the sedimentational history of salt domes as affected by structural growth will result in a more accurate interpretation of the growth history of domal uplifts, and should be the goal of future studies.

Seismic Velocity Effects May Hide Organic Reefs. D. C. Van Siclen. Part 1. *World Oil 148,* 118 (1959) Apr. (5 pp.); Part 2. *Ibid.,* 178 (1959) May (5 pp.)

Usefulness of this effect for mapping reefs depends on degree of velocity contrast between the limestone and shale. Theoretical analysis shows that this contrast decreases with increased limestone porosity, as oil replaces water and gas replaces oil, and as depth of burial becomes greater. Geologically reasonable changes can be envisaged which would render a reef practically unrecognizable. In general, it is potentially more producible reefs that are less likely to show up. Part 1 provides data for estimating the amount of various structures that a little known reef can be expected to produce. Such information, it is pointed out in Part 2, might be used to forecast the effectiveness of seismic exploration. And it might later be used with seismic data to interpret the shape of the limestone body and the attitude of reflecting horizons masked beneath it. Chief physical uncertainty in an estimate of false seismic structure is the wave velocity in the limestone structure since velocity varies with changes in the lithologic and interstitial fluid properties of the rock.

Soviets Look at Direct Oil Detection. V. A. Sokolov, S. A. Alexeyev, E. A. Bars, A. A. Geodekyan, G. A. Mogilevsky, U. M. Yurovsky and B. P. Yasenev. *Oil Gas J. 57,* 138 (1959) June 8.

Results of comprehensive researches carried out during recent years in the USSR on the development and application of geochemical, biochemical and radiometric methods of prospecting and exploring oil and gas fields.

Logging

Improved Accuracy in Porosity Determination. A. A. Brown. *Petrol. Eng. 31,* B-92 (1959) May (5 pp.)

Device for measuring borehole wall resistivity known as the microlaterolog, a focused-current logging instrument, was first introduced in 1952. It has since proved to be more accurate than the earlier microlog for determining formation factor and porosity and is now widely used as a formation evaluation tool. The microlaterolog determines formation factor and porosity of a reservoir rock from resistivity measurement of the flushed zone surrounding the borehole.

Sonic Logging. M. P. Tixier, R. P. Alger and C. A. Doh. *J. Petrol. Tech 11,* (T.P. 8063) 106 (1959) May (9 pp.)

Principle, equipment and field operation of sonic logging are described. Two-receiver system produces

logs independent of hole size and mud. Field experience is given and forms the basis for the interpretation of the log. Derivation of porosity values from measured velocities is discussed according to the type of formations. A time-average equation proposed by Wyllie, Gregory and Gardner is used as a basis for the computation of porosity in limestones, cemented sandstones and compacted sands. Variations in the lithologic character of limestones do not seem to change the porosity calibration markedly. Compaction of sands is related to the compaction of shale adjacent to them; and thus the shale velocity is used for the establishment of empirical relations for the computation of porosity in unconsolidated formations. Various formulas are tenetatively presented to account for shale and fluid content. Article is illustrated with field examples.

What's the Score on Neutron Logging? A. H. Youmans and C. W. Zimmerman. *Oil Gas J. 57,* 139 (1959) June 8 (3 pp.)

Most promising new development in recent years is the accelerator neutron source and its application to oxygen-activation logging. Other improvements in the last four years are, in apparatus, 1) properly engineered scintillation-counter-type instruments; 2) improvements in quality and variety of neutron sources; 3) development of a gamma-gamma density logging tool with absolute density calibration; 4) adaptation of a variety of improved radiation detectors, permitting a greater variety of logging measurements; 5) introduction of small-diameter tools (1¾ and 1⅜ in. in diameter) for through-tubing work, and 6) development of gamma-ray instrumentation rugged enough for attachment to a perforating gun. Important new techniques in the same period include 1) flowing-neutron logs; 2) cement-top location; 3) multispaced-neutron logs, and 4) chlorine detection.

Offshore Operations

Choosing Offshore Equipment. A. J. Field and H. Stratton. *Oil Gas J. 57,* 121 (1959) May 11 (2 pp.)

Authors list six things to remember when choosing offshore equipment: 1) Anticipated drill depth and hole size; 2) weather and oceanographic data, including wave heights, wind velocity, tidal-vertical variation and current; 3) bottom condition; 4) casing (or completion) program; 5) supply and distance to port facilities and 6) water depth range.

Louisiana Has Best Offshore Future. *Oil Gas J. 57,* 106 (1959) June 8 (2 pp.)

Success ratios in offshore exploration have hovered at 70% off the coast of Louisiana; lower ratio off Texas results in an over-all offshore success of 60%. As of July 1, 1958, a total of 2029 wells had been drilled in gulf waters. This includes wildcat and field wells, and 1356 of them were successful. They have produced 169,400,000 bbl of oil and condensate and 755 billion CF of gas. Of the 2029 drilled, 1896 were drilled off Louisiana, resulting in 1302 producers and 1586 productive completions as a result of dual and triple completions. Reserves of oil and condensate now proved in the offshore waters amount to 2.5 billion bbl, it is estimated. In addition, 9.5 trillion CF of gas has been found. Only a negligible amount of this total reserve can be attributed to Texas.

New Look in Offshore Drilling. D. L. Black. *Petrol. Eng. 31,* B-104 (1959) May (4 pp.)

Relatively new platform is making its presence known in Gulf Coast drilling activities. The "Petrel" is designed with a working capacity of over 20,000 ft, and incorporates a versatile blowout preventer system capable of handling any pressures encountered in its working area. Currently it is drilling for Placid Oil Company in an area south of Morgan City.

Second American-Side Test Opens Drilling Season on Lake Erie. *Petrol. Week 8,* 28 (1959) May 1 (2 pp.)

Lake Erie's drilling season has opened with the second American-side test, now on location off Pennsylvania. This test, to be drilled by New York State Natural Gas Corp., is located some 35-40 miles east of the first hole drilled on the American side of the lake last summer. New York Natural, who also drilled last summer's test, owns the only two lease blocks granted by Pennsylvania for lake drilling.

Tempo Quickens on Lake Erie. B. C. Donnan. *Oil Gas J. 57,* 222 (1959) June 1 (5 pp.)

Offshore gas play in Lake Erie promises to move into second gear in the 1959 season with approximately 110 wells planned. During 1958, 56 were completed, including three additional wells being suspended pending completion in 1959, giving 31 gas producers. During 1959, 15 drilling towers are expected to be in operation with many wells to be drilled from piling platforms as well. The lake currently is divided into three areas: The western, central and eastern parts. Activity in each section is discussed.

Petroleum Production

Salt Domes of East Texas Basin. H. H. Krusekopf, Jr. *Oil Gas J. 57,* 143 (1959) May 4 (4 pp.)

East Texas is spotted with 17 known piercement domes and at least 10 established deep-seated domes. Most of the known deep-seated domes are

productive of oil or gas. The piercement domes have recently assumed importance as oil producers or potential oil producers and article is concerned with these.

Pipeline Systems

Velocities are Critical in Two Phase Gathering Systems. D. Green and R. L. Huntington. *Petrol. Eng. 31,* C-29 (1959) May (3 pp.)

From the very nature of the gas condensate single phase reservoir fluid, unitization is found to be the most feasible and economical method of producing these fields (particularly those in the Gulf Coast region). Without unitization, various operating difficulties would arise, such as the transport of fluids through the reservoir from one lease to another due to unequal withdrawal and reinjection rates by different companies within the same field. Many other unavoidable inequities would result from competitive operation of properties by their respective companies, hence the marked trend toward the cooperative arrangement, making for maximum earnings to the companies and royalty owners as well as conservation of natural resources in this country.

Recycling

Results of Gas Injection in LL-370 Area, Lake Maracaibo. P. N. Weidner and E. R. Bower. *Oil Gas J. 57,* 145 (1959) June 8.

First project of a large-scale gas-conservation effort in Lake Maracaibo was completed by the Creole Petroleum Corp. for the LL-370 area in October, 1954. Article summarizes data accumulated from the project and indicates that gas injection will yield 30-40% more oil than could have been achieved by following a pressure-depletion program.

Reservoir Engineering

New DST Technique Yields Better Formation Samples. A. W. Smith. *World Oil 148,* 155 (1959) May (5 pp.); **Use of Nitrogen in Drillstem Testing.** *Petrol. Eng. 31,* B-37 (1959) May (3 pp.)

Use of nitrogen under pressure instead of the conventional water cushion normally used in drill stem testing operations has provided excellent results for operators in the West Texas area. When used in conjunction with a control valve that may be positioned at any point in the testing string, any specific length of drill pipe or tubing may be pressured with nitrogen to any desired value prior to the test. Chief advantages of the technique are better formation samples, less rig time and the versatility and safety of nitrogen.

Pressure Inversion and Material Balance Calculations. H. N. Mead. *J. Petrol. Tech. 11,* (T.N. 2033) 65 (1959) May (3 pp.)

In a reservoir when gas comes out of solution and rises, additional pressure is created because of the change in position of this gas in the bounded volume. If this pressure effect is not taken into account as a pseudo-influx in material balance calculations on reservoirs in which there is evolving gas, an error is introduced that is directly proportional to the length of oil column and the amount of gas evolved and inversely proportional to the reservoir pressure. In reservoirs with small oil column this pseudo-influx is of little importance. The larger the column of oil the more important the effect becomes. The most important application, however, will be for reservoirs with declining pressure in which increasing water entry has been indicated by material balance calculations. It could be that this indication is the result of the cited pseudo-influx and not water entry at all. Article attempts to explain this phenomenon in relation to material balance calculations and presents an approximate method of determining the pseudo-influx.

Secondary Recovery

Pilot Propane Project Completed in West Texas Reef. W. C. Sturdivant, Jr. *J. Petrol. Tech. 11,* 27 (1959) May (4 pp.)

Injection of a 14,000-bbl slug of propane into a reef reservoir in an advanced stage of gas injection operations has resulted in miscible displacement of 100,000 bbl of stock-tank oil. Premature breakthrough of gas injected behind the slug is attributed to dilution of the propane slug, to unfavorable permeability distribution and to an insufficient amount of propane.

Well Practice

Fracturing Pays Off in Eastern United States. W. S. Moore. *Oil Gas J. 57,* 162 (1959) May 25 (4 pp.)

For the period 1949-54, fracturing averaged 59% gel fracture, 36% sand fracture and 5% acid fracture. Gel fracture used a thickened or gelled oil or kerosene as the carrying medium, sand fracture used lease crude or refined crude, and acid fracture used an acid-kerosene gel or an acid gel. In 1958, over 20% of the fracture treatments used water as the carrying medium, either gelled or in its natural state or sometimes as a weak acid (3%). All early fracture jobs used tubing as the injection string, but over 50% of fracture treatments in the Appalachian area in 1958 were performed down 4½, 5½ or 7-in. casing. By the end of 1954, the average treatment

on many formations was 2000-2500 gal of fracture fluid while some jobs used 4500 gal. Only treatments larger than these were the sand fracture treatments in the oil producing area of the Clinton sand in Ohio. Today the average treatment for shallow gas producing horizons is 4000-8000 gal of gelled oil or 10,000-20,000 gal of water. Treatments of 12,000-20,000 gal in the deeper horizons of Pennsylvania and West Virginia and the Clinton sand are common. Fracturing of newly completed and old wells has become an integral part of the natural gas and oil industry in the Appalachian area. Fracturing of water injection and producing oil wells in secondary recovery projects is now accepted completion procedure.

Here's How to Improve Your Gas Lift Installations. H. W. Winkler. *World Oil 148,* 162 (1959) May (5 pp.)

Pressure survey prior to installation of gas lift equipment represents a small expenditure which can save an operator many dollars. Savings may be in initial equipment or higher operating efficiency from a properly designed installation or both. Pressure element employed for a survey always should be compatible with the pressure to be measured (i.e., 0-6000 psig range element should not be used to measure 300 psig). A fast chart drive clock should be used in the bomb for temperature and pressure surveys for detailed analysis of gas lift operation. Certain precautions are required when running a survey in a gas lift well being produced by intermittent lift. Use of the temperature survey for quantitative work in gas lift wells is overlooked by many operators.

A New Look at Workover Fluids. R. W. Ruhe, Jr. *Petrol. Eng. 31,* B-118 (1959) May (9 pp.)

Workover programs and fluids are becoming more important despite the tremendous forward strides in the past few years by secondary recovery processes. These processes have not yet reached the ultimate—100% recovery of the available hydrocarbons. While they do increase the recoverable oil in the reservoir, they cannot overcome damage inflicted to the reservoir during the drilling and primary recovery stages. This means that greater care must be exercised during the primary producing stage.

What Phillips Learned from Cementing 136,790 ft of Hole on Its Three Pecos County, Texas, Deep Tests. J. O. Woodson and C. L. Fulton. *Oil Gas J. 57,* 170 (1959) May 25 (9 pp.)

Testing of cement blends for deep well jobs led to these conclusions: 1) At bottom hole temperatures above 260° F, the cement blend should be tested before the job is run; 2) at high temperatures, it becomes more difficult to retard the slurry as weight decreases below 13.5 lb/gal, and 3) use of silica flour results in a cement blend which has superior qualities for deep, high-temperature squeeze jobs. Phillips wells were the 1-EE University (TD 25,340 ft), the 1A Montgomery (TD 23,400 ft) and the 1A Harral (TD 19,020 ft).

4. GAS CONDITIONING AND LPG RECOVERY

Carbon Dioxide

Absorption of CO_2 in Jets and Falling Films of Electrolyte Solutions, with and without Chemical Reaction. R. A. T. O. Nijsing, R. H. Hendriksz and H. Kramers. *Chem. Eng. Sci. 10,* 88 (1959) Nos. 1/2 (17 pp.)

In this article the kinetics of the absorption of CO_2 by caustic solutions have been studied. To this end, the rate of CO_2 absorption by a laminar jet and by laminar falling film was measured. In the first case, the contact times were very short which permitted operation under conditions where the absorption can be interpreted as a diffusion of CO_2 into the liquid accompanied by a rapid pseudo first-order reaction. From these experiments the reaction velocity constant between CO_2 and OH^- ions could be derived for KOH, NaOH and LiOH solutions up to 2N at 20° C. In the experiments in the wetted wall column, the situation was approached where the absorption rate was determined by the diffusion of CO_2 and OH^- to a narrow reaction zone where a rapid second-order reaction between CO_2 and OH^- occurs. Results of these measurements agreed well with the theoretical prediction. For the correct interpretation of the measurements great care was exercised with respect to the hydrodynamic conditions and to the values of the physical properties involved such as the "solubility" and diffusivity of CO_2 in reaction solutions and the diffusivity of OH^- ions in the liquids.

Gasoline

Design Economies Begin with Modernization of Gasoline Plant Specifications. N. C. Turner. *Petrol. Eng. 31,* C-8 (1959) May (5 pp.)

Unless frequently and critically reviewed and revised, mechanical specifications can become antiquated, defeating their purpose. Specifications which fail to allow for modern technological developments in equipment, and changing economic conditions, can be a serious detriment to economical design of the modern plant. Wherever possible, specifications, standards or codes established by the industries manufacturing the various items of process equipment should be followed.

New Concepts of Marginal Gasoline Plant Design. S. W. Smith. *Petrol. Eng. 31,* C-13 (1959) May (3 pp.)

Present trend is toward more high efficiency plants processing gases at high propane and ethane extraction, but every year this problem becomes more pressing as it becomes more difficult to find sufficient quantities of gas to economically support a plant. Justification for these high extraction plants is the ever-increasing demand for chemical raw materials and consequent increase in value of propane and ethane.

Operator's Handbook for Gasoline Plants. Part 1. Plant Operation. Manu. Dept., Bay Petroleum Co., TET. *Petrol. Refiner 38,* 155 (1959) May (6 pp.)

Prepared by plant superintendents and operating staff, this handbook is written so that the new and experienced operator can understand the most important operations of a natural gasoline plant. First part discusses four of the major items of consideration in the design, erection and operation of a modern gasoline plant; namely, feed stock, process flow, design characteristics and products.

Three Basic Processes for Modern Gasoline Plant Design. G. D. Johnston. *Petrol. Eng. 31,* C-3 (1959) May (3 pp.)

Selection of the most economical process (absorption, refrigeration, adsorption) with regard to new capital outlay is primarily contingent upon plant capacity, physical conditions of the gas stream, and the degree of product recovery desired. In addition, with current inflationary trends, the process selected must also provide flexibility of operation and product recovery, simplicity of operation and a minimum of utility requirements.

Hydrogen Sulfide Removal

Operation of Liquid and Gastechnik Purification Plants at Cardiff. J. Powdrill. I.G.E. Communication No. 551. *Gas World 149,* 1058 (1959) May 30 (2 pp); *Gas Times 93,* 55 (1959) May (2 pp.); *Gas J. 298,* 460 (1959) June 3 (3 pp.). **Discussion.** *Gas Times 93,* 64 (1959) May.

Details are given of two new types of gas purification plants to meet the particular requirements at the Cardiff undertaking of the Wales Gas Board. Full description of each plant is presented with details of operation, costs and information from plant experience. First author describes a liquid plant and its development to insure complete reliability of H_2S removal, to statutory requirements, operating direct into holders. The second part of the report not only deals with a Gastechnik tower installation operating very successfully with the removal of H_2S to statutory requirements, but, also, a new method of recovering high quality elemental sulfur, and an oxide pellet-making plant of original design, are described.

Putting to Work the Natural Gas Deposits at Lacq. J. Fouchier and M. Vicart. I.G.E. Communication No. 543. *Gas World 149,* 1033 (1959) May (6 pp.); *Gas Times 93,* 42 (1959) May (2 pp.); *Gas J. 298,* 439 (1959) June 3. **Discussion.** *Gas Times 93,* 60 (1959) May.

Lacq natural gas deposits were discovered in 1951 at a depth of 3500 m. Since the gas is highly corrosive, due to its high hydrogen sulfide content and to its temperature, special steels had to be studied and developed for the exploratory boreholes and producing wells. Since the recoverable reserves in the deposit were at least 150,000 MMCM, planned production, which will be reached in 1961, was fixed at 20 MMCM/day of gas. Before this gas can be transported and marketed, it must undergo chemical treatment for removal of sulfur and of petrol, and also recovery of the sulfur. This recovery is carried out by the Claus process. In the first section of the plant, in operation since May, 1957, desulfurization is carried out by absorption of the acid gases by diethanolamine, and petrol removal by absorption in oil at low temperature. In the section put into operation at a later date, part of the sulfur is removed by washing with water under pressure; whereas petrol is removed by several cascade cooling stages.

Recovery of Hydrogen Sulfide from Gas with the Aid of Ammonia Water. F. Rosendahl. **Part 1. Scrubbing Hydrogen Sulfide from Gas.** *Gas-u. Wasserfach 100,* 263 (1959) Mar. 13 (5 pp. German text); **Part 2. Stripping of Ammonia and Hydrogen Sulfide from the Concentrated Liquor.** *Ibid.,* 362 (1959) Apr. 10 (5 pp. German text); **Part 3. Recovery of Ammonia from the Gas.** *Ibid.,* 477 (1959) May 8 (4 pp. German text.)

Author begins the series with a discussion about the patented processes for the recovery of hydrogen sulfide from gas with the aid of ammonia water. In Part 2, he discusses the stripping of the ammonia liquor and in Part 3 the scrubbing of ammonia from the gas by the newer patented processes.

Scotland to Have High-Pressure Purifiers for Westfield Works. *Gas Times 93,* 32 (1959) May (2 pp.)

Type of iron oxide tower purifier never before used in Scotland will be incorporated in the Lurgi pressure gasification plant which the Scottish Gas Board is building at Westfield in Fife. A contract for building the purifiers, to have a capacity of 30 MMCF/day of gas, has been awarded. Cost will be in the region of £150,000.

Sulfur Recovery from Refinery Gases. R. W. Rieve, P. M. Pitts, Jr. and L. N. Leum. *Oil Gas J. 57,* 180 (1959) June 8 (3 pp.)

New process developed by Atlantic Refining Co. uses a basic aqueous solution of a multivalent ion such as iron in conjunction with a chelating agent to absorb hydrogen sulfide and oxidize it to sulfur. Iron is reoxidized by air either concurrently or separately to make a continuous operation. Sulfur is formed as a finely divided solid which may be recovered by settling, filtration, or preferably as a liquid by heating the suspension above the melting point of sulfur. Article describes this process which has been studied only on a laboratory scale. However, there have been no problems uncovered in this work that would indicate difficulty in scaleup.

Carbon Dioxide Removal

Low-Temperature Gas Absorption. M. Kwuak (assigned to Hydrocarbon Research, Inc.) U.S. 2,880,591 (1959) Apr. 7.

Hydrogen and other fuel gases are purified of carbon dioxide by scrubbing with acetone at 50 psig in successive rich and lean countercurrent absorption zones, with regeneration of acetone by heat exchange respectively with rich and lean zone stripping with inert gas.

Condensate Recovery

Processes and Apparatus for Recovering Hydrocarbons from Gas Streams. W. M. Dow. U.S. 2,880,818 (1959) Apr. 7.

Propane, butane and natural gasoline are recovered from raw gas by a pair of adsorption beds, alternately on an absorbing circuit and on a regenerating gas circuit. The latter includes heating, condensing and separating means with pump circulation and provision for cooling the bed by passage of unheated gas.

Hydrogen Sulfide Removal

Method for Separating CO_2 and H_2S from Gas Mixtures. H. E. Benson and J. H. Field (assigned to the U.S.A. as represented by the Secretary of the Interior.) U.S. 2,886,405 (1959) May 12.

Concentrated, fresh or regenerated solutions of potassium carbonate, phosphate or alkanol amines are passed downward under 50 psig pressure, at a temperature between 100°-300° C, through a bubble cap column where they meet a rising flow of crude gas, whereupon CO_2 and H_2S react with solution to form soluble bisulfides and bicarbonates. The fouled solution passes to a regeneration column (a bubble-cap tower) through a pressure-reducing valve and the CO_2 and H_2S are boiled out of the solution by direct or indirect steam. CO_2 and H_2S are recovered as overhead of regenerator by vacuum pump and the solution concentrated by condensers and returned to first scrubber. A fouled-solution flash chamber and heat exchangers may be used in solution lines.

Purification of Coal Distillation Gases. O. Grosskinsky, A. Adelsberger and K. Klempt. U.S. 2,884,304 (1959) Apr. 28.

Hydrogen sulfide is removed from a coal distillation gas also containing ammonia by compressing and cooling to obtain a highly concentrated ammonia condensate, then scrubbing compressed gas with a solution more dilute in ammonia, separating the diluted H_2S bearing solution, adding concentrated condensate to replenish NH_3 and recycling the purified ammonia solution to the first scrubbing stage. Carbon dioxide also is removed concurrently from the gas.

Removal of Hydrogen Sulfide from Hydrocarbons. S. Bozich, A. J. Shmidl and J. W. Smalling (assigned to Esso Research and Engineering Co.) U.S. 2,884,377 (1959) Apr. 28.

Hydrocarbons boiling up to 450° F are treated for removal of H_2S by contacting a slow flow of hydrocarbons with a particulate bed (20 mesh) of quartz wetted by 50° Be. sodium hydroxide solution. At intervals the bed is water-washed free of the exhausted film of sodium hydroxide and reactivated by soaking with fresh reagent.

5. NATURAL GAS TRANSMISSION

Automation

In Pipelining, Centralized Control Can Best be Achieved by Systems Engineering. M. T. Nigh. *Oil Gas J. 57,* 154 (1959) June 1 (4 pp.)

Systems engineering involves the application of automation to a number of different fields. Result is the development of complex data handling systems which are readily adaptable to centralized control.

Communications

Combination Microwave-Wireline Solves NGPL's Communication Needs. C. E. Upson. *Petrol. Eng. 31,* D-38 (1959) May (3 pp.)

Operating requirements of the Natural Gas Pipeline in recent years created the need for additional channels of communication along the pipeline route. These channels must accommodate services such as VHF mobile relay, data transmission, telemetering, supervisory control, etc., as well as voice communications. Company accomplished this by 1) constructing a microwave radio relay system between

Chicago and Beatrice, Neb., to replace wire lines in this area, 2) installing four channels of telephone carrier on Natural's existing wire lines between Beatrice, Neb., and Fritch, Texas. and 3) installing two channels of telephone carrier on Natural's existing wire lines between Fritch and Amarillo, Texas. These facilities provide direct channels between 1) Chicago-Amarillo, 2) Chicago-Fritch-Amarillo, 3) Chicago-Beatrice, and 4) Beatrice-Fritch; party line facilities include 1) microwave service, 2) field operations, 3) pipeline maintenance, 4) gas dispatching and 5) VHF relay. These installations will increase Natural's field communications system from 3540 channel miles to 8065 channel miles of service.

Compressors

Applied Hydrocarbon Thermodynamics. Part 10B. Charts for Making Compressor Calculations. W. C. Edmister. *Petrol. Refiner 38,* 195 (1959) May (8 pp.)

Equations and charts for compressor calculations are explained. This covers irreversible compression, temperature exponent, irreversible expansion, temperature rise, volumetric efficiency and multistage compression. Typical indicator cards are included to illustrate the effect of clearance volume on these calculations.

Flexible Compressors with Piston Pockets. J. E. Mallow. *Petrol. Refiner 38,* 151 (1959) May (4 pp.)

More than 1000 clearance pocket pistons have been manufactured for use in Phillips' compressor operations. A large number are also being used by other compressor operations. All new and rebored compressor cylinders for Phillips' operations are equipped with these pistons. When added clearance is needed, it is available in the pistons without any additional cost. Cost of these pistons is only a small amount above a conventional piston. Since this type of piston has been available, practically all new compressor cylinders are purchased at least 10% larger than required for initial operations and clearance is added to the piston to give greater flexibility in future operations.

Engines

MIT Indicator Gives Fast Check on Engine Performance. J. M. Ranck. *Oil Gas J. 57,* 116 (1959) May 11 (4 pp.)

Engine indicator must fulfill task of displaying or recording a variable pressure in the form of a pressure-vs-time diagram. Many ways of producing these diagrams have been devised; however, most widely used today is perhaps the mechanical type. Many present-day design and operating improvements in the gas industry can be directly attributed to the use of the MIT high-speed engine indicator, which has been shown to be very accurate in producing dynamic pressure recordings of cyclic pressure phenomena.

Engine Wear

Wear in Pipeline Engines and Compressors: Methods of Measurement. D. V. Kniebes. (New York: A.G.A. Project NB-16; Inst. Gas Tech. Technical Rep. No. 1; 35 pp. $1.50.) May, 1959.

Two-year study of the wear history of 84 pipeline compressor engines in relation to the concentrations of metals in the lubricating oils from these engines has demonstrated the feasibility of using lubricating oil analyses as a means of detecting increased rate of wear of engine components prior to their failure in service. Inexpensive emission spectrographic analyses were used to determine the metal content of the lubricating oil samples in the ppm range. Nondetergent lubricating oils from most of the engines which operated normally during the study contained low concentrations of wear metals. It therefore was possible to indicate tentative upper limits for metal concentrations in nondetergent oils from normally operating engines. Information obtained in this study will permit individual pipeline companies to evaluate the merits of lubricating oil analysis as a preventive maintenance tool for their own operations, and will furnish a basic understanding of the methods used to properly interpret analytical data.

Fluid Flow

Generalized Solution for the Problem of Pipe Flow with Friction and Heat Addition. R. W. McJones and M. L. Caplan. *ARS J. 29,* 366 (1959) May (3 pp.)

Generalized chart method is presented for the rapid solution of pipe flow problems involving compressible fluids, including the combined effects of friction and heat addition. A typical chart is shown for the case of subsonic air flow through a duct of unspecified but constant wall temperature. Similar charts can be constructed for other problems.

New Subsurface Flowmeter. R. C. Rumble, H. M. Buck and B. A. Peters. *Oil Gas J. 57,* 104 (1959) May 11 (4 pp.)

Tool will satisfy need for a reliable meter to determine rate of flow at various points in a well bore. It will aid in correcting trouble in injection wells as well as in oil and gas producers.

Metering

Offshore Gas Measurement—Why and How. C. E. Terrell. New York: A.G.A. Operating Section Pro-

ceedings; Paper No. GSTS-59-5; (1959) May; *Gas Age 123,* 30 (1959) June 11 (4 pp.)

Why of offshore gas measurement can be covered in rather brief terms; how is a much more complex problem. Presentation, based on several years operation on the Louisiana Gulf Coast, considers measuring stations reachable only by water or air transportation, whether in open water or in the marshlands, to be in the offshore category. Since the operations are similar, they vary only in degree in respect to rough weather conditions. Author discusses equipment design, corrosion protection, installation, operation and maintenance involved in offshore gas measurement.

Pipeline Construction

The Transmission of Gas in Wales. W. T. Hird. I.G.E. Communication No. 548. *Gas World 149,* 1041 (1959) May 30 (3 pp.); *Gas Times 93,* 39 (1959) May (2 pp.); *Gas J. 298,* 464 (1959) June 3 (2 pp.) **Discussion.** *Gas Times 93,* 61 (1959) May.

Particular attention is given to the developments since 1953 in the design and construction of pipelines in Wales to operate at pressures up to 250 psi. Factors that led to the introduction of an American "pipeline spread" are discussed and a description given of the construction methods used. Reference is made to the costs of construction and to the application of "pipelining" methods to the construction of small-diameter pipelines. Some details of the application of cathodic protection to the pipelines are given, together with an account of the methods used for metering and volume control. Mention is made of the financial and commercial results of the construction work described, and the article concludes with a section dealing with possible future developments in gas transmission in Wales.

Pipeline Operations

One Line—Four Products. A. N. Horne. *Oil Gas J. 57,* 119 (1959) May 25 (4 pp.)

Existing conventional crude oil pipelines can handle a wide variety of the direct and indirect products of oil and gas wells. With modifications, lighter and more volatile hydrocarbons can be added to the list. For future construction, proper basic design could provide for these broader possibilities. Article outlines a limited experience in handling varying mixtures of natural gas liquids, middle distillates, heavy ends and crude oil from South Oklahoma to the Chicago area through a conventional crude oil pipeline system, modified for tight-line operation.

You Can Take a Pipeline's Pulse Internally. H. J. Endean, R. M. Howard and J. E. Knizner. *Oil Gas J. 57,* 123 (1959) May 25 (5 pp.)

Report of a study made to determine the feasibility of conducting internal surveys in pipelines. Investigation indicated that surveys could probably be made for a number of operating and maintenance factors. It disclosed a variety of measuring procedures that were readily adaptable for continuous recording while the instruments are pumped through a pipeline. A few of the measurable variables that could be recorded were grade, curvature, roughness, pressure, temperature, leakage and possibly electrical potential. Possibility of modifying pipeline operating conditions for surveys was considered. It was concluded that to be generally acceptable, surveys should require no special conditions as to either delivery rate or equipment between terminals. It was agreed that minor modifications of terminal equipment would be feasible.

Telemetering

Great Lakes Pipe Line Designs a Watchdog. *Pipe Line News 31,* 37 (1959) May (4 pp.)

Great Lakes Pipe Line Co.'s problem was to find a dependable device which could be installed in a remotely controlled station and which would automatically signal the control point if and when the atmosphere within the pump room of the unattended unit became dangerous because of an accumulation of gasoline vapors. Indicator designed as a result of a research program works on the following principle: An air sample, taken from a trench near the pump, is drawn outside the building into a combustion chamber containing a spark plug. Twenty-four times each minute the plug sparks. If the atmosphere is combustible there is a small explosion inside the chamber which activates a signal circuit to the controlling station.

6. GAS AND LPG STORAGE

Gas Holders

Anti-Freezing Measures for Gasholders. J. A. Scott. *Gas J. 298,* 246 (1959) May 6 (4 pp.)

Methods available for dealing with gasholder freezing can be divided into four groups: 1) Heating and water circulation by means of a hot water circulator; 2) heating and water circulation by means of steam injection; 3) electrical heating, and 4) electrical heating combined with mechanical circulation. A further possible method is by the introduction of anti-freezing additives to the holder water but this is not usually considered on the ground of expense and/or corrosion problems.

Storage

Field Erected Storage Tanks. A. F. Fino. *Cost Eng. 4,* 4 (1959) Apr. (15 pp.)

One of the major costs entering into a chemical or processing plant is the investment for storage vessels. Depending upon the type of gas, liquid or solid to be stored, the initial cost of the storage vessels could represent a substantial portion of the capital investment. It is, therefore, important that the proper type of vessel be selected for the required storage conditions. A large variety of field erected vessels are available for servicing every phase of industry, and may be classified as 1) fixed volume steel tanks, including cylindrical, flat bottom cone or dome roof tanks; sphere, bullets, ellipsoids and special shaped vessels; underground tanks; elevated vessels; and alloy vessels, and 2) conservation steel tanks, including steel floating roofs; plastic floating covers; and diaphram equipped tanks.

Propane Storage at 35° F. *Chem. Processing 22,* 75 (1959) June (3 pp.)

Method of storing propane at 35° F and 57 psig—in use at Alabama Gas Corporation's new peak shaving plant at Birmingham — was selected as the most economical for the purpose of the plant. Three 51-ft diam., 520,000-gal (12,000 bbl) insulated and refrigerated spheres are used to store the liquid propane. Propane itself serves as the refrigerant. In quantities below 10,000 bbl, propane is usually stored in unrefrigerated vessels designed to withstand 250 psi. Since quantity in this case was considerably larger, vessels designed for a maximum pressure of 75 psig were selected. This lower pressure permits thinner steel to be used for tanks, with a substantial savings in capital costs. Also, a sphere is the ideal shape for storage. It will hold a maximum quantity of liquid/lb of metal used.

The Storage and Use of Butane. A. A. H. Clark and L. A. Warren. *Gas J. 298,* 288 (1959) May 13 (5 pp.)

Article discusses the use of butane/air as a suitable mixture for augmentation to gas supplies at times of peak demand, the plant required to store butane and use it when mixed with air as a source of peak load gas and includes some operational results as well as other uses to which butane may be applied. Requirements for a plant to supply gas at a reasonable price on a poor load factor are 1) low capital cost, 2) low operating costs, 3) minimum maintenance, 4) simple operation with minimum manning and supervision, and 5) production of a gas which can be mixed with normal town gas in suitable proportions to give a gas with satisfactory combustion characteristics.

Underground Storage

Gas Storage under a Metropolitan Area. J. H. N. Ellis and T. C. McLean. New York: A.G.A. Operating Section Proceedings; Paper No. GSTS 59-4 (1959) May; *Gas Age 123,* 28 (1959) May 28 (4 pp.); *Gas 35,* 123 (1959) June (8 pp.)

Pacific Lighting system is composed of Pacific Lighting Gas Supply Company, Southern Counties Gas Company, and Southern California Gas Company, serving all of Southern California with the exception of San Diego County and the City of Long Beach. San Diego Gas and Electric Company serves all of San Diego County but purchases all of its gas from the Pacific Lighting group of companies. Long Beach has a municipal system but purchases part of its gas from the group. Out-of-state gas first entered Southern California in 1947 with initial deliveries of about 125 MMCF/day; at present, the Pacific Lighting group of companies is importing about 1.04 billion CF/day and is waiting regulatory approval to increase daily imports to 2 billion CF by 1962. Need for storage also is evident by the fact that the group's peak day requirements are more than 7 times greater than the average daily needs, while the peak hour sendout is double the daily rate of the peak day. At present, the system operates four underground gas storage projects at Goleta, Playa Del Ray, East Whittier, and Montebello. Latter storage project, located within the city of Montebello adjacent to Los Angeles, is described.

Maintaining the Balance between Supply and Demand. J. W. Hart. *Gas 35,* 117 (1959) June (6 pp.)

Description of the Oakford storage project, located in Westmoreland county in southwestern Pennsylvania, which was developed jointly by New York State Natural Gas Corp. and Texas Eastern Transmission Corp. Murrysville sand pool was initially drilled in 1878. Sand is approximately 1400 ft below ground level and is 100 ft thick. Open flows range from 10-40 MMCF/day in each of the many wells drilled. The Fifth Sand pool, discovered in 1907, is at a depth of 2200 ft and is about 60 ft thick. Well open flows range to 30 MMCF/day with a maximum rock pressure of 1100 psig. Pool study indicated the formations would hold 105,000 MMCF of storage gas, 20,000 MMCF in the Fifth Sand pool at 1200 psig and 85,000 MMCF in the Murrysville sand. Of the 105,000 MMCF total storage, 60,000 MMCF was to be withdrawn at a rate averaging 400 MMCF/day for 150 days. Pipelines to the storage property for each party, who share equally in the output, terminated at the compressor station. Gas was to be received for storage at a minimum pressure of 450 psig. Gas was to be delivered to the transmission pipelines at a pressure

of 850 psig. All gas delivered was to be free of extraneous materials such as water, oil and solids to an acceptable pipeline level. Problems in developing this pool are outlined and their solutions discussed.

Storage

Storage of Liquefied Gases. K. H. Faulk (assigned to Cities Service Refining Corp.) U.S. 2,884,763 (1959) May 5.

System for liquefied petroleum gas storage is claimed in which economy in refrigeration is obtained by initially flashing some incoming liquid, then withdrawing, compressing, and condensing the vapor to incoming liquid, indirectly exchanging its heat with delivered cold liquid from storage and passing the heated liquid in heat exchange with an independent heat transfer medium which may be a calcium chloride brine.

Underground Storage

Hydraulic Fracturing to Develop Underground Storage Caverns. H. V. Hendrix and E. S. Miles (assigned to Phillips Petroleum Co.) U.S. 2,880,587 (1959) Apr. 7.

Improved technique is claimed for forming underground LPG storage caverns in soluble strata by drilling inlet and outlet wells spaced laterally and cased from the surface to the top and bottom, respectively, of the soluble strata, fracturing a channel between the wells and dissolving out a cavity along said channel by continuous circulation of water between the inlet and outlet wells.

Method and Equipment for Handling Volatile Liquid Hydrocarbons. K. O. Johnson, K. J. Nuber, H. H. Waddell and R. E. Miller (assigned to Esso Research and Engineering Co.) U.S. 2,880,593 (1959) Apr. 7.

Storage system for volatile liquid hydrocarbons is claimed which comprises a storage cavity at sufficient depth below ground-water table to maintain a water pressure to keep hydrocarbons in a liquid state. The cavern is preferably lined with hydrocarbon-impervious lining and has a domed space in the upper (hydrocarbon) part to permit insertion of an outlet pump, as well as a separate side-shaft for introducing water to the bottom of the cavern where it maintains a seal between inverted weirs to avoid overflows.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Acetylene

Which Acetylene Removal Scheme is Better? W. H. Stanton. *Petrol. Refiner 38,* 177 (1959) May (4 pp.)

Most economical method (absorption or hydrogenation) for acetylene removal depends on variables such as plant size, byproduct value of acetylene, and acetylene made per 100 lb of ethylene produced. Boundaries on the conditions which favor hydrogenation and destruction of the acetylene and those which favor absorption and recovery of the acetylene for sale are established in article.

Carbon Dioxide

Air Separation. Carbon Dioxide Removal by Adsorption. E. Karwat. *Chem. Eng. Progress 55,* 79 (1959) May (2 pp.)

Process described is applicable to air separation plants using conventional shell-and-tube heat exchangers. It meets present-day demands for carbon dioxide removal by eliminating caustic scrubbing and by offering the highest degree of safety for air separation plants as far as dangerous accumulations of hydrocarbons in the cold box are concerned. Both improvements are realized by this removal, just above the dew point, of the carbon dioxide, and also the hydrocarbons such as acetylene by means of adsorption, for example, with silica gel. Two interchangeable adsorbers are used. Before the adsorber in use is exhausted, it is exchanged for one that is freshly regenerated, regeneration being effected by allowing a gas which is free of CO_2 to flow through the adsorber. This may be done at the temperature of adsorption, or by simultaneously warming up the adsorber to ambient temperature.

Coal

Coal-Ash Slags. Part 1. Formation and Mineralogy. J. D. Watt. *BCURA Monthly Bull. 23,* 49 (1959) Feb. (21 pp.)

It is an essential part of the design of certain modern combustors and gasifiers that the mineral constituents of coal should be removed from the system as a liquid slag, rather than as an ash or clinker. In the design of plant of this kind, knowledge of the properties of coal slags is of critical importance, and article discusses such aspects of their formation, constitution and physical properties as seem to be relevant to the problems which have been met in practice. This part is concerned particularly with the chemistry of the reactions of the coal minerals and with the chemistry and mineralogy of the solid slag obtained as a final product.

Coal Chemicals

Hard Coal's Big Break in Chemicals — Maybe. *Chem. Week 84,* 21 (1959) May 23 (2 pp.)

Two diversified, largely non-chemical companies are moving cautiously toward a possible $100-million joint venture in chemicals from coal. If successful, the venture would be credited in CPU annals as establishing anthracite coal particles as a major chemical raw material. Companies involved are Philadelphia & Reading Corp., which has been working on this problem for years, spurred by the problems afflicting its big hard coal mining operations in east-central Pennsylvania, and General Dynamics Corp., a newcomer to this project but well known in such industrial fields as electronics, nucleonics, aircraft, missiles and nuclear submarines. Latter company has recently acquired Liquid Carbonic Corp. in an effort to balance its heavy defense revenues with more substantial commercial sales.

Ethylene

Isotopic and Hot Radical Effects in the Reaction of Hydrogen Atoms with Ethylene. A. H. Turner and R. J. Cvetanovic. *Can J. Chem. 37,* 1075 (1959) June (7 pp.)

Reactions of D atoms with C_2H_4, H atoms with C_2D_4 and H atoms with C_2H_4 at room temperature are compared. Pronounced differences in the extent of isotopic exchange have been found. Observed isotopic and pressure effects provide evidence for the importance of "hot" ethyl radicals in these reactions and their responsibility for isotopic exchange. Atoms are generated by the mercury-photosensitized decomposition of hydrogen and deuterium and their concentration is sufficiently small so that "atomic cracking" does not occur.

Gasification

Kinetics of the Steam-Carbon Reaction. G. Blyholder and H. Eyring. *J. Phys. Chem. 63,* 693 (1959) May (4 pp.)

Data for the steam-graphite reaction from 900-1300° and in the 5-100 μ pressure range are presented as a function of both pressure and temperature. Rate-determining processes are the adsorption of water vapor and the desorption of molecular hydrogen from the surface. Absolute rate theory calculations lead to the conclusion that the adsorbed species have a limited mobility upon the surface.

Hydrogenation

Hydrogenation—Here Today and Here Tomorrow. W. E. Bradley, G. W. Hendricks, H. C. Huffman and A. E Kelley. *Oil Gas J. 57,* 194 (1959) June 8 (5 pp.)

Hydrocracking of crude oils, heavy residua and highly aromatic catalytic cycle oils is expected to appear on the U.S. petroleum refining scene in the near future. Ever-present problem of lower hydrogen-to-carbon ratios in available crudes as compared to those desired in quality distillate fuels should force the development of an economic new hydrocracking process and may also promote the use of an older process, coking.

Hydrogenation of Toluene with Raney Nickel Catalyst. Reaction Kinetics. Catalyst Structure and Properties. H. Littman, H. Bliss and D. Dew-Hughes. *Ind. Eng. Chem. 51,* 659 (1959) May (6 pp.)

In a study of the liquid phase hydrogenation of toluene with a Raney nickel catalyst between 131.3° and 171.4° C and pressures up to 100 atm, the initial rates (under 20% conversion) were found approximately zero order in toluene and 0.5 order in hydrogen concentration. A chain mechanism is proposed to explain these observations, which suggest a catalyst concentration order greater than 1. To prove that the catalyst does not age or change its structure during hydrogenation, it was analyzed by metallographic and X-ray techniques. The Raney nickel catalyst used was found to be an inhomogeneous single-phase alloy, face-centered cubic, with broad X-ray lines and a lattice parameter of 3.53 A.

Oil Gas

Early Experiences on the Catalytic Oil Gas Plant at Carlisle. N. Ollerenshaw. *Gas World 149,* 876 (1959) May 9 (5 pp.)

In England, many works have a surplus of waste heat steam and Humphreys and Glasgow, therefore, in conjunction with the West Midlands Gas Board, built a small pilot installation at Solihull designed on the regenerative principle. In this, heat is retained in a regenerator instead of raising steam, with consequently higher oil conversion efficiencies. Following experimental work on this plant, commercial units of a smaller type were designed in a range from 300,000 to 5 MMCF/day. The first commercial unit put to work was the Carlisle installation with a daily capacity of 1 MMCF. Article considers plant itself as well as the objects and theory of the process.

Ore Reduction

A Review of Direct-Reduction Ironmaking Processes. E. S. Paige. *Eng. Digest 20,* 196 (1959) May (7 pp.)

Summary of the latest progress in the various techniques proposed or developed to provide an answer to the problem of producing iron without a blast furnace. Among the many different unconventional ways of making iron, exceptional importance attaches to the direct-reduction processes, which employ low reducing temperatures and a simple reducing tech-

nique based on solid or gaseous fuels, and which produce sponge iron or iron powder, instead of pig iron. Picture would not be complete, however, without including ironmaking methods which result in products similar to pig iron, but which utilize inferior fuels and new types of equipment, such as low-shaft furnaces, electric smelting furnaces or rotary kilns.

Petrochemicals

The Oxo Process Today. V. N. Hurd and B. H. Gwynn. *Oil Gas J. 57,* 199 (1959) June 8 (4 pp.)

Chemical companies have largely used the Oxo process as an alternate method of producing existing products. Aldehydes and alcohols of five carbons or less were already being produced in large quantity for use as such and for conversion to higher- molecular-weight products such as 2-ethylhexanol. These are now produced, at least in part, from ethylene, propylene and butylenes by means of the Oxo process. Aside from this interest, chemical companies have shown some tendency to branch out into the direct production of Oxo derivatives from the higher olefins as well. Looking to the future, it seems reasonable to assume that the Oxo process will continue to be an important and growing means of converting olefins to aldehydes. While solvent and plasticizer alcohols have been the principal end products manufactured on a large scale, much work has been done and will continue to be done to find new and more rapidly expanding derivatives of the primary aldehyde products. For example, alcohol for use in the detergent field continues to have promise, and it is expected that additional Oxo derivatives, such as acids, amines, polyols, and others, will appear in increasing numbers, thus contributing to the continued growth of the Oxo process.

Petroleum Refining

Advances in Petroleum Chemistry and Refining. Vol. II. Edited by K. A. Kobe and J. J. McKetta, Jr. New York: Interscience Publishers, Inc., 1959. 634 pp. $14.50.

Like its predecessor (see *Gas Abstracts 14,* 230), the second volume of this series presents detailed studies of progress in particular subjects in the dynamic field of petroleum chemistry. The same five-part grouping is maintained as well as the same wide selection of authoritative contributors. The economics and trends group opens fittingly with an analysis of petrochemical raw materials, which, though consuming only 2% of all gas and petroleum, have provided the most spectacular tonnage chemical growth and most variegated processing developments since 1940. Optimum economic selection of feedstocks and effects of yields of coproducts are discussed with butadiene-styrene rubber production as an example. A similar wartime sister industry — that of lubricants and their synthetic relatives—is discussed in the second paper. Intensive basic research on principles of lubrication, friction, surfaces and structure of compounds is described with a citation of 345 items. Under unit operations, the use and design of pebble heaters for thermal cracking occupies a large chapter. Leadership of the petroleum industry in applications of radioactive isotopes is effectively outlined in the largest (103 pp.) chapter, which can almost serve as a handbook of methods. Commercial systems, unit design and operation of sulfuric acid alkylation for high-octane fuels are presented from a manufacturing standpoint. Upgrading of residues into distillates by removal of Conradson carbon and associated metallics receives a thorough treatment, with commercial data on stocks and products from the delayed, fluid and contact coking processes. Completing the section on refining is the chapter on radiation processing, discussed from the standpoint of fundamentals of radiation and of its modes of interaction with matter, together with sources, cost estimates and description of existing applications. Synthetic detergents from petroleum and commercial hydrazine comprise the two chapters in the petrochemicals section. The first deals primarily with production of dodecylbenzene sulfonates, used principally in household detergents (345 million lb in 1956), but also includes other sulfonate products. The second discusses the production of hydrazine by various processes and the properties and uses of this material in further synthesis. Diverse product uses such as corrosion inhibitors, fluxes, pharmaceuticals, insecticides, dyes, rubber chemicals and especially rocket fuels have helped to maintain commercial interest in hydrazine. The final section and chapter discusses the mechanical aspects of the Houdriflow catalytic cracking process. This process exemplifies the modern moving bed catalytic cracking methods for gasoline production, and a complete detailed treatment of the operation throughout the cracking cycle is given.

Pyrolysis

A Study of the Catalytic Dehydrogenation of Propane during Introduction of Additional Hydrogen into Reaction Zone. V. V. Keltsev and N. I. Vinnikova. *Gazovaya Prom.* 36 (1959) No. 5 (6 pp. Russian text.)

When propane is converted to ethylene by pyrolysis in the presence of an alumo-chromium catalyst there is considerable carbon desposition which retards and eventually prevents further reaction. Laboratory tests revealed that the addition of hydrogen reduces

this rate of carbon formation; 10% hydrogen (based on propane volume) reduces carbon formation in half and 50% hydrogen reduces carbon formation to 1/8. Other advantages are increased ethylene yield and a wider range of optimum operating temperatures.

J. W. Penney

Reformed Gas

Reforming at Romford. Refinery Gases Increase Capacity Tenfold. *Gas J. 298,* 283 (1959) May 13 (4 pp.)

By reforming refinery tail gases, a potential saving of 306,000 tons of coal/yr and a consequent reduction in coke production by 115,000 tons has been made possible at the North Thames Gas Board's new gasworks at Romford. Plant consists of four Onia-Gegi units for the reforming of the refinery tail gases, one pair of which can also use primary flash distillate, and an oil gasification plant divided into two units and capable of gasifying any feed stock from P.F.D. to heavy oil of 1000 seconds' viscosity. Design capacity of each reforming unit is 9 MMCF/day and that of the gasification plant, 2 MMCF/day for each unit.

The Romford Gas Reforming Plant. J. Burns and E. R. Stewart. I.G.E. Communication No 550. *Gas World 149,* 1020 (1959) May 30 (6 pp.); *Gas Times 93,* 37 (1959) May (3 pp.); *Gas J. 298,* 441 (1959) June 3 (2 pp.). **Discussion.** *Gas Times 93,* 64 (1959) May.

Two large refineries situated at Shell Haven and Coryton in the eastern part of the North Thames Gas Board area, provide a valuable source of raw material for supplementing the Board's gas supplies. Further, the Board can see the possibilities of accepting natural gas into Canvey where the Board owns land with deep water berthing on the river. Article describes the provisions made to accept the actual and potential raw materials into the Board's framework of gas manufacture. Onia-Gegi plant ultimately selected is described in some detail, and operating results over a period of some nine months are included.

The Use of Propane/Butane for Gas Making in Vertical Retorts. N. V. Steenstrup. I.G.E. Communication No. 545. *Gas World 149,* 1059 (1959) May 30 (3 pp.); *Gas Times 93,* 51 (1959) May (2 pp.); *Gas J. 298,* 439 (1959) June 3 (2 pp.); **Discussion.** *Gas Times 93,* 63 (1959) May (2 pp.)

Description of use of propane/butane for gas making by passing, or so-called "purging", the vaporized butane/propane through the red-hot coke bed in vertical, primarily intermittent, retorts during the steaming period. A mixture of propane/butane and superheated steam is introduced into the retorts through the normal channels for steaming. In the retorts, the propane/butane is reformed to a gas enriching the water to a purge gas that has a specific gravity of 0.45 and a calorific value of approximately 340 Btu/CF. Thus, the principle allows for a higher addition of purge gas than of water gas from steaming under normal operation.

Sulfur Oxides

Cost Estimates of Liquid Scrubbing Processes for Removing Sulfur Dioxide from Flue Gases. J. H. Field, L. W. Brunn, W. P. Haynes and H. E. Benson. *U.S. Bur. Mines Rep. Invest. 5469.* (Washington: U.S. Dept. of the Interior, 1959.)

Capital and operating costs have been estimated for removing sulfur dioxide from flue gases of a power-plant of 120,000 kw capacity by liquid-purification processes, using limestone, ammonia or sodium sulfite as the reactant. Latter two processes yield end products that may be marketable. Coals containing about 1.5 and 5% sulfur have been considered. Sulfur dioxide content of the gases to be treated is 0.083 and 0.30%, respectively. Estimates have been made for 90% removal of the sulfur dioxide from both gases. A third instance has been considered in which 70% of the sulfur dioxide is removed from the flue gas of 0.30% concentration. The scrubbed gas would contain 0.09% sulfur dioxide, which might be within the permissible limit for discharge for the atmosphere in most areas. Although it is unlikely that flue gases with sulfur dioxide concentrations of less than 0.10% would require purification, a cost estimate for such a gas is included because an estimate is available for a British plant employing the limestone process at these conditions. For the flue gas containing 0.30% sulfur dioxide, capital costs range from about $1.75—5 million, and operating costs from $1.4 to 2.2/ton of coal consumed, allowing credit for products. This is based upon the annual consumption of 475,000 tons of coal.

Underground Gasification

Power Station Operating on Coal Seam Gas. *Gas World 149,* 948 (1959) May 23; **Power Station Operates on Gas.** *Gas J. 298,* 323 (1959) May 20.

Gas produced at the underground gasification project developed by Humphreys and Glasgow, Ltd., for the National Coal Board at Newman Spinney, near Chesterfield, is operating a 3.75-mw power station. An entirely new system is being used. A shaft was sunk to the coal seam and a gallery driven horizontally. From this gallery boreholes were drilled

within the coal seam for distances up to 450 ft. These boreholes were a considerable achievement since the seam is only about 27-in. thick and the holes are 14 in. in diameter.

Fractionation

Demethanization of Cracked Gases. J. W. Davison and J. R. Cobb, Jr. (assigned to Phillips Petroleum Co.) U.S. 2,880,592 (1959) Apr. 7.

Cracked gas containing methane, ethylene, ethane, propylene and considerable hydrogen is demethanized by chilling in successive stages to —120°F at 780 psia, separating condensate from each and expanding uncondensed gas through a turbine to —220°F, fractionating this final and all separate condensates in a fractionating zone to separate a high-methane overhead and ethane-ethylene bottoms.

Hydrocarbons

Apparatus for Detecting Hydrocarbons in Drilling Mud and Cuttings. C. A. Youngman (assigned to The Atlantic Refining Co.) U.S. 2,883,856 (1959) Apr. 28.

Hydrocarbons are detected in the drilling mud and the rock cuttings carried by it by sampling the mud stream from the well, and grinding the mud and cuttings together in a closed, serrated disc mill. Any released hydrocarbons are passed into a detector cell of resistance filament type where combustion causes current variations which may be continuously recorded.

Hydrogenation

Coal Hydrogenation. P. C. Keith and F. Ringer (assigned to Hydrocarbon Research, Inc.) U.S. 2,885,337 (1959) May 5.

Improved yields of light products in coal hydrogenation are claimed by a process in which the coal is pasted with oil, hydrogenated at 10,000 psig and 875° F to 75% conversion of coal carbon. The products are separated to remove vapor phase at 400°-600° F and heavier oils and suspended solids then are cracked in a fluidized catalyst bed in the presence of hydrogen at 1200°-1300° F. Residual carbon remains in the fluid bed and is circulated to a lower gasification zone, reacted with O_2 and steam to yield hydrogen for hydrogenation and for the upper cracking zone, while the cracked overhead is withdrawn for fractionation.

Oil Gas

Process for the Pyrolysis and Gasification of Hydrocarbonaceous Materials. M. P. Sweeney (United Engineers & Constructors, Inc.) U.S. 2,884,368 (1959) Apr. 28.

Process is claimed for pyrolysis of hydrocarbons which comprises injecting the hydrocarbons into a hot moving stream of gases and entrained fine carbonaceous solids to heat to 1100-1800°F and partially pyrolyse the feed. The stream then passes into a fluidized bed of said solids where the valuable vapor products are separated from the bed, and some of the carbonaceous solids are removed continuously from the bed. A portion of these solids are burned in a separate vessel to produce heating gases for transporting and reheating the remaining solids as a suspension stream.

Ore Reduction

Apparatus for Reducing Ferruginous Ores Containing Substantial Amounts of Manganese. B. R. Babbitt and C. B. Kunz (assigned to Manganese Chemicals Corp.) U.S. 2,880,988 (1959) Apr. 7.

Improved method for reduction of manganiferous oxidic iron ore avoids formation of "dead burned" non-leachable manganese compounds. It comprises contacting down-flowing pulverized ore with upflowing H_2 or CO gases in a shaft furnace at a temperature from 800°-880° F. Ore is heated by an intermediate injection of hot combustion gases which blend with reducing gas rising from the base of the shaft.

Pyrolysis

Fixed Bed Regenerative Refractory Pyrolytic Gas Conversion Process. H. A. Lindahl (assigned to The Pure Oil Co.) U.S. 2,886,615 (1959) May 12.

Improved economy is obtained in fixed-bed pyrolysis of hydrocarbons for ethylene and acetylene products (wherein the hot reaction zone moves upward through the fixed bed during the "make" and must be moved back downward), by using an inert gas purge to drive part of the hot zone downward into an auxiliary heat storage pebble bed. When reheating of the reaction ("hot") zone begins, the fuel gas and air are preheated to 1500° F in the auxiliary stage. (See also U.S. 2,885,455, below.)

Process for Chemical Pyrolysis. H. Hennig (assigned to The Pure Oil Co.) U.S. 2,885,455 (1959) May 5.

Improved production process for acetylene, ethylene and propylene is claimed which comprises two 18-ft deep fixed beds of 3/16-in. mullite pebbles in vertical reactors with rotary heat exchangers. The beds are first heated by gas to 2000° F for about seven feet, leaving the remaining bed length as quench zone. After a brief steam purge, pure ethane is added with steam (1:5 mole ratio), cracked in hot zone, and then quenched in upper cool (300° F) zone. The hot zone moves upward in pebble bed while

its temperature falls, and the upper quench zone shortens, reducing its effectiveness, while the lowest (entrance) zone becomes cold. When the upper quench zone depth drops to two feet, the reactant flow is reversed and the lower cool zone is used as a quencher. When the hot zone temperature drops to 1700° F, propane is fed instead of ethane. At 1500° F, the feed is stopped, the bed is purged and reheated while a second reheated vessel continues the processing. (See also U.S. 2,886,615, preceding.)

Refining

Catalytic Pressure Refining of Hydrocarbons of Low Boiling Point in the Presence of a Mixture of CO and Hydrogen. H. Nonnenmacher, W. Oettinger and O. Reitz (assigned to Badische Anilin- & Soda-Fabrik A.G.) U.S. 2,884,370 (1959) Apr. 28.

Sulfur, oxygen and nitrogen compounds are removed from low boiling oils by catalytic pressure refining with hydrogen containing 4-20% carbon monoxide, after an initial preheating stage.

Shale Oil

Hydrocracking Shale Oil. I. Kirshenbaum, K. K. Kearby and H. J. Ogorzaly (assigned to Esso Research and Engineering Co.) U.S. 2,884,371 (1959) Apr. 28.

Process for converting high sulfur and nitrogen shale oil to a high octane motor fuel is claimed, which includes contacting the oil in a reactor at 950-1100°F and 100-700 psig with a silica-alumina cracking catalyst containing 8-16% by wt of molybdenum oxide in the presence of hydrogen-rich gas.

Process and Apparatus for Retorting of Oil Shale. L. P. Evans (assigned to Socony Mobil Oil Co., Inc.) U.S. 2,885,338 (1959) May 5.

Shale oil is recovered by a process of passing lump shale downward through a shaft retort, with rising hot combustion gases transferring their heat to cold shale while oil and condensate are condensed in this upper zone and withdrawn as side streams. Preheated shale passes down through a constricted zone into the retorting zone proper where vapors are driven out by hot gas from oxygen-air blast through a lower grate which burns out the residual carbon of the heated shale.

Shale Retorting Process. C. H. O. Berg, J. E. Hines, Jr., J. R. Hunt, C. P. Reeg and J. H. Ballard (assigned to Union Oil Co.) U.S. 2,881,117 (1959) Apr. 7.

Shale retorting process is claimed in which raw shale is fed upward by means of a hydraulic charging piston into superimposed zones for shale preheating, distillation, spent shale combustion and ash cooling, with burned spent ash overflowing the upper lip while a countercurrent stream of air flows downward through the bed. Said bed is kept stirred and in a permeable state by three helically formed plow blades, which are hollow, cooled by recycled molten sodium and hydraulically rotated. Oils and gases released in the distillation zone are cooled, condensed and removed through perforated walls below the preheating zone.

8. GAS DISTRIBUTION

Distribution Systems

The Construction of Small Diameter High Pressure Grid Gas Mains. S. N. P. Nelson and H. Breeze. *Gas World 149,* 870 (1959) May 9 (5 pp.)

For the construction of the greater part of the North Wales Gas Grid and for the Western Section of the South Wales Grid, American pipeline methods, suitably modified for conditions in Great Britain, were used. Because of the success of these projects it was believed that, with further modification, such methods might be adopted for laying smaller diameter high pressure pipelines, both quickly and economically, to supply the small and remote undertakings. Authors were responsible for the organization and operation of two construction units in North and South Wales. Units were formed to lay small diameter pipelines using the modified pipeline methods. Each unit is responsible for the selection of grid main routes, preparation of estimates, organization of plant and labor, and the construction of the mains. These units are self-contained and all the administrative work is carried out in mobile site offices. An essential feature of the system is that weekly records of progress and costs are maintained so that proper control may be exercised and the financial state of the work be immediately available.

Four Ways which Can Be Used in Laying Gas Mains across Rivers. F. Bell. *Gas Times 93,* 43 (1959) May (3 pp.)

Author has described the laying of gas mains across rivers by four methods: 1) Through a road tunnel; 2) by thrust boring; 3) by trenching in the river bed, and 4) attached to the structure of a road bridge. First method is rather exceptional in that there are relatively few road tunnels under rivers and still fewer where consent to the laying of a gas main would be obtained. Other three methods are typical of those usually adopted for river crossings — the only alternative being the special pipe bridge or in the case of short spans the self-supporting pipe —

but detailed descriptions of the design of the mains and the methods used in laying them are useful.

How to Increase Capacity of Existing Systems. At Consumers Power . . . Appliance Regulators, Remote Control, and Time-Cycle Pressure-Boosting Increase Capacity. M. L. Bock. *Am. Gas J. 186,* 26 (1959) June (4 pp.)

Consumers Power Company (Jackson, Mich.) found it necessary to search for ways to increase existing system capacity to adequately serve its customers and enable it to avoid and delay costly main replacements. Three rather successful methods are in operation: application of regulation which allowed company to increase distribution pressures during peak load periods from 4 to 6-in. w.c. to 10 to 14-in. w.c. to increase its supply; remote control to change the pressure settings of district regulator stations as conditions and demands dictate and automatic time cycle pressure boosting by means of a time cycle intermitter or clock arrangement.

How to Increase Capacity of Existing Systems. In Detroit . . . Service Regulators, Elevated Pressures Help Mich-Con Meet Vast Expansion Needs. P. B. Thompson. *Am. Gas J. 186,* 29 (1959) June (3 pp.)

Removal of all spaceheating restrictions which had been imposed on the Michigan Consolidated Gas Company in some form or other from November, 1942, until August, 1949, brought both a large increase in the housheating load and a problem of supply to customers supplied by the company's low pressure distribution system. Plan for improving supply to customers adopted was that of elevating distribution pressure to 1½ or 2 psig and installing service regulators.

How to Increase Capacity of Existing Systems. In Philadelphia . . . Three-Phase Program on Three-Pressure System Uses Time-Temperature Loaders, Telemetering. H. C. Missimer. *Am. Gas J. 186,* 22 (1959) June (5 pp.)

Philadelphia Gas Works operates the gas system within the city limits and mains cannot be extended outside of these. Philadelphia covers 129 sq miles and contains some 560,000 gas customers, who are supplied by some 2600 miles of mains. The 750 Btu gas is distributed over a system using three pressure levels: High pressure that has a maximum operating pressure of 30 psi; medium pressure that operates at a maximum pressure of 6 psi, and a low pressure system that operates between 4½ and 8½-in. w.c. Increases in capacity have accomplished by 1) increasing the high pressure system capacity by the omission of service regulators on large industrial customers; 2) increasing the medium pressure system capacity by elimination of step-down regulator between the high and medium pressure systems, and 3) increasing the low pressure system capacity by means of loading regulators.

How to Increase Capacity of Existing Systems. In St. Louis . . . Additional District Regulators and Temperature Boosters Prove Practical. E. F. Trunk. *Am. Gas J. 186,* 31 (1959) June (2 pp.)

In three successive winters, Laclede Gas Company's peak load went from 100 MMCF to 190 MMCF to 300 MMCF/day. Studies indicated that to meet this increasing demand it would be favorable, economically, to stay on a low pressure system and increase capacity by increasing the number of feedpoints or district regulators. This quite naturally led to the installation of automatic temperature boosters. Low pressure system is now designed and operated to maintain 8½-in. w.c. pressure at the regulator outlet (compared to 6-in. w.c.) and 4½-in. w.c. pressure at the system low point during the maximum hour. At temperatures above 65°F, the district regulator has an outlet pressure of 6-in. w.c. which provides approximately 5-in. w.c. pressure at the system low point.

Organization of the Hong Kong and China Gas Company. T. Spikins. I.G.E. Communication No. 544. *Gas World 149,* 1037 (1959) May 30 (4 pp.); *Gas Times 93,* 48 (1959) May; *Gas J. 298,* 459 (1959) June 3 (2 pp.) **Discussion.** *Gas Times 93,* 60 (1959) May (2 pp.)

Present development of gas distribution in the United Kingdom can be described as the construction of a large efficient works pumping gas into a grid system of high-pressure gas mains. These mains, by supplying communities and areas of supply at some distance from the central plants, are resulting in the closing down of smaller and/or less efficient works. Hong Kong is doing the same thing although on a very much smaller scale, and such small-scale efforts offer interesting points of comparison with the major projects in Britain, particularly where factors peculiar to Hong Kong are taken into account.

Leakage

Internal Sealing of Gas Mains by the "Never Leak" Method. C. P. Xenis. New York: A.G.A. Operating Section Proc.; (1959) Apr.; **Con Ed Gas Mains 'Never Leak.'** *A.G.A. Monthly 41,* 16 (1959) May (4 pp.); **The "Never Leak" Method for Internal Sealing of Gas Mains.** *Am. Gas J. 186,* 18 (1959) June (4 pp.)

During 1957 and 1958, wide application was made of the "never leak" method of internally sealing gas mains in the gas distribution system of Consolidated

Edison Co. (N. Y.), mainly in the Westchester area. Selection of the type of liquid sealant was the result of extensive investigation, experimentation and improvements after trial. It must perform the following functions: 1) Fill the interstices in the bell and spigot joint, and leave a permanent filler; 2) accomplish the sealing operation even though the jute in the joint is partially or completely deteriorated due to the drying effect of natural gas, and 3) upon drying or curing, the liquid must leave a thickness of a rubber-like material, chemically and physically unaffected by gas, its components, odorizer, etc. Performance to date, economics and other considerations have been gratifying. Basic concepts, type of equipment used and a summary of test results and experience obtained to date with the "never leak" method are reviewed.

Loss of Gas from Mains. J. S. Fox-Andrews. *Gas J. 298,* 324 (1959) May 20 (2 pp.)

Major difficulty always has been to locate the point where leakage occurs. Possibility of using radioactive isotopes was considered, but another method tried in the mining industry for detecting the presence of gas evolved. In this method, small samples of the atmosphere under the ground surfaces are obtained and are passed over a hot wire. East Midlands Gas Board conducted its first experiment with this method two years ago in Swadlincote when 36 miles of main were surveyed and, as a result, 219 leakages, including 22 broken mains, were discovered and repaired.

Metering

Shop Testing of Large Capacity Meters. H. J. Evans. *Gas Age 123,* 31 (1959) May 14 (3 pp.)

Proper meter testing consists of more than just placing the meter in adjustment at the various flows. When the meter is adjusted, the length of the tangent, the valve timing, and assembly should be carefully noted. An improperly built meter can usually be adjusted until it is accurate, but it will not maintain its accuracy in operation. If the tangent length must be appreciably changed from the normal setting it indicates that something is wrong with the meter. Usually there is too much friction or the diaphragms are collapsed. If the valves are not properly adjusted the meter will not operate smoothly, which results in greater wear. The last test on the meter should be a flow test of about 2 CF/hr. Test must be sufficiently long for the meter to make one complete cycle so that any valve leaks can be detected.

Synthetic Diaphragms for Gas Meters. E. C. Hemes. New York: A.G.A. Operating Section Proceedings; (1959) Apr.; *Gas Age 123,* 22 (1959) June 11 (3 pp.)

While what is available today looks good, future progress may be expected. New elastomers are appearing constantly, each with its own peculiar advantages and disadvantages. Future is in hands of research chemists who already have new products of potential merit under test. It is not unreasonable to assume that eventually temperature compensation, built into the diaphragm without detracting from existing desirable features, will be an accomplished fact. Author includes two tables to demonstrate what can be engineered into a coated fabric.

Odorization

Factors Affecting Stability of Odorants in Gas Mains. A. H. Wicht and I. Deutsch. New York: A.G.A. Operating Section Proceedings; (1959) May; *Gas Age 123,* 35 (1959) May 28 (3 pp.)

New mains can be odor-conditioned after installation by the one shot injection or spraying of an oil-odorant mixture of approximately one part odorant to eight parts heavy oil. Internally coated epoxy resin, if economically feasible, appears to be effective solution to the removal of odorant in new mains, in addition to a solution to internal corrosion and oxide dust problems.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Conditioning

Airborne Condensation Droplets, Ions May be Major Health Factors. K. E. Schaefer. *Heating, Piping & Air Conditioning 31,* 101 (1959) May (5 pp.)

Droplets and ions were measured in the atmosphere of fleet-type submarines and were found significantly increased during periods of submergence. Data presented in article go beyond submarines. It would apply to any occupied closed structure housing ion-generating materials. This is the first time that this information has been made available in the U.S.

Dynamics of Fresh Air as Seen from the View of Ionization in a Changing Environment. J. C. Beckett. *ASHRAE J. 1,* 47 (1959) May (5 pp.)

Temperature, humidity, purity and air movement can be controlled to a reasonable degree. Pressure can be controlled where essential (space flight and submarines), but generally this is uneconomical. Radiations are recognized but not controlled, including solar radiation, cosmic radiation and radioactivity. Superimposed on this set of conditions is the

large unknown of bioclimatology—the effect of outdoor climate, the seasons and weather on man when he passes from one climate to the next. Air ionization is a bioclimatical factor which to date has not been controlled. It has been learned that an excess of negative ions is beneficial particularly for the respiration of hay fever sufferers and an excess of positive ions with air pollution irritates the throat and decreases respiration capacity. There is still need, however, for correlation of air ion density with other climate factors.

Air Pollution

Air Pollution Control as Related to Oil Combustion. J. L. Dupuis. *Fueloil & Oil Heat 18,* 83 (1959) May (4 pp.)

Article admonishes that in certain cities oilburners are becoming the target of the men who aim to make the skies clearer and the air cleaner than it is today. Actions of burner manufacturers, sellers, installers and service organizations can be hampered by lawmakers and the use of fueloil actually can be curtailed if air pollution requirements of certain types are made law and enforced. Keeping well informed about legal controls over the use of oilburners and fueloils — related to air pollution — is a new role which properly should be played by advocates of the use of oilburners and fueloils. Highlights of New York's new requirements for the installation of oil-fired equipment are cited.

Effectiveness of Odor Counteractants for the Treatment of Stack Gases. M. W. First. *J. Air Pollution Control Assoc. 9,* 28 (1959) May (4 pp.)

Brief study represents the only available objective data on the effectiveness of odor counteractants for the reodorization of stack gas effluents. Author hopes it will stimulate advocates of this system of stack gas treatment to perform and publish studies of a scientific nature which will demonstrate the fields of usefulness, if any, of odor counteractants and/or masking agents in air pollution control activities.

An Index of Air Pollution and Its Relation to Health. N. E. Manos and G. F. Fisher. *J. Air Pollution Control Assoc. 9,* 5 (1959) May (7 pp.)

U. S. cities can be ranked according to an index of air pollution based on general sources of air pollution such as home heating, automobiles and industry. This index, in its various forms, has been correlated with mortality for various causes using several age-sex-race breakdowns. Objective is to determine which forms of the index correlate with mortality. Findings to date indicate that four causes of death produce a large number of high positive correlations with the various indexes of air pollution, namely: 1) Malignant neoplasm of esophagus and stomach; 2) malignant neoplasm of the trachea, bronchus and lung; 3) arteriosclerotic heart disease, including coronary disease, and 4) chronic endocarditis not specified as rheumatic, and other mycardial degeneration.

Some Considerations in the Interpretation of Air Pollution Health Effects Data. R. A. Prindle. *J. Air Pollution Control Assoc. 9,* 12 (1959) May (8 pp.)

Data presented indicates no evidence to support an assumption of a causal relation between the diseases studied, i.e., malignant neoplasm of trachea, bronchus, lung, esophagus and stomach, arteriosclerotic heart disease including coronary disease, chronic endocarditis not specified as rheumatic and other myocardial degeneration, and ulcer of stomach and duodenum, and air pollution. Many other factors exist, accounted for only partially or not at all, which may affect the distribution of deaths as shown in the tables and graphs. Socio-economic status, genetic make-up, ethnic differences, and meteorological phenomena are examples of such factors.

Drying

The Vital Metal Drum. E. Ford. *Gas J. 298,* (Gas in Industry Sect.) 122 (1959) May 6 (4 pp.)

Description of operations at London Containers & Noakes Ltd., of Beta Works, London, leading British manufacturer of metal drums and allied products. All stages of the manufacture of steel drums are carried on at the factory where assembly line methods have been devised and applied to the particular processes involved. Basic raw material consists of sheet steel of various gauges, many thousands of tons of which are used annually. This steel is fabricated into drums and painted and it is in this latter process that gas-fired ovens are used to dry the painted drums. In addition, certain of the drums are tested in water tanks before painting, and these drums are dried in gas-fired ovens before passing to the painting stage.

Explosion Limits

Determining the Explosibility of Mine Atmospheres. M. G. Zabetakis, R. W. Stahl and H. A. Watson. *U.S. Bur Mines Inf. Circ. 7901.* (Washington: U.S. Dept. of the Interior, 1959.)

Simplified graphic method for determining the explosibility of mine atmospheres under mine-fire conditions from mine-atmosphere condition data is presented. Sometimes it is necessary to seal part of a mine during a fire to exclude air and thus extinguish the fire. Unfortunately, liberation of methane and formation of hydrogen and carbon monoxide in the

sealed area may create an explosive or flammable atmosphere if enough oxygen is present to support combustion. On the other hand, the oxygen concentration may be reduced through combustion processes and the concentration of inert gases (nitrogen and carbon dioxide) increased enough to render the atmosphere within the sealed area non-explosive. Before an area is unsealed, it is extremely important to know if the sealed atmosphere contains flammable gases in proportions that might form explosive mixtures when air is introduced. If an explosive mixture forms and the fire is rekindled, a gas explosion will result. Various experimental methods may be used to determine the explosibility of a particular mine atmosphere; however, these methods usually are impracticable in the field.

Flame Research

Chemical Properties as Methods of Achieving High Temperatures. D. Altman. PB 131549. (Washington: U.S. Dept. of Commerce.) Price: $0.75.

Study has been conducted of those chemical reactions capable of yielding very high temperatures. Study has shown that the most critical quantity limiting high temperatures in flames is the bond energy. A survey of diatomic species indicates that the N-N bond and the C-O bond are the two most energetic bonds known. Consequently, chemical reactions which form only these two species are capable of delivering the highest temperatures attainable by chemical means alone. Variations in flame temperature for a specific reaction can be achieved through variation of pressure or volume. The effectiveness of this control of the state variables is discussed in relation to the degree of dissociation of the combustion gases.

Furnaces

The Aerodynamic Approach to Furnace Design. J. H. Chesters. New York: ASME Ann. Meeting, (1958) Nov-Dec. Paper No. 58-A-72 (9 pp.) (From *Appl. Mech. Rev. 12*, 357 (1959) May.)

Flow patterns and mixing in actual furnaces can be best appreciated by starting with free jets and proceeding via jets in simple envelopes to jets (cold or alight) fed with surrounding air streams and impacting on surfaces. The fuel stream in an open-hearth furnace behaves initially as a free jet, entraining the relatively low velocity air around it, but on hitting the bath it splashes and runs forward and up the side walls. The gases reaching the roof eject flux droplets and then divide, part recirculating to meet the oncoming air and part joining the main flow to the exit. Future progress requires more knowledge of droplet dynamics, and demands more symmetrical flow, control of recirculation, or radical changes.

Basic Principles of Combustion-Model Research. A. A. Putnam and E. W. Ungar. New York: ASME Ann. Meeting, (1958) Nov-Dec. Paper No. 58-A-73 (6 pp.) (From *Appl. Mech. Rev. 12*, 357 (1959) May.)

Use of models to study problems encountered in the design of commercial and industrial combustion equipment is less well known than the use of their counterparts for aeronautical, hydraulic, erosion and similar studies. The basic assumptions upon which cold-flow modeling of combustion systems is carried out, the application of modeling to various combustion problems, and the type of results that should be expected from the application of modeling techniques are discussed.

From authors' summary

Gas-Fired Furnaces Speed Meter Repair Soldering. C. A. McFadden. *Am. Gas. J. 186*, 34 (1959) June (2 pp.)

Compact, gas-fired soldering iron furnaces expedite meter maintenance at Northern Illinois Gas Company's new half-million dollar meter shop in La Grange, Ill. Radiation is developed by a cup-shaped radiant burner that becomes incandescent when fired. This operation produces heat transfer rates higher than possible with conventional furnaces. Furnace recovers from 500° to 1000° F in less than 4 min, burning less than 9 CF of natural gas/hr, when a cold 2-lb iron is inserted. Furnace burns pre-mixed gas and air without flame impingement on the soldering copper, which is surrounded and protected by fully burned gases.

New Vertical Furnace Improves Annealing of Stainless Strip. D. L. Somers and C. A. Turner. *Ind. Gas (Amer.) 37*, 2 (1959) May (3 pp.)

Furnace described is designed for a maximum strip speed of 50 fpm and is capable of handling strip 0.001-0.020-in. thick and 8-26-in. wide. Maximum muffle temperature is 2100°F, though annealing will not always require this peak strip temperature. Furnace consists of two opposing burner panels located 9 in. from either side of the muffle. Each panel, approximately 40-in. sq, contains radiant burners patterned in four horizontal rows. Burners are fired by pre-mixed gas and air, with combustion taking place within the confines of the burner cup. Heat transfer takes place predominantly by radiation, and is characterized by the avoidance of flame beyond the cup surface. Heating chamber proper is about 6-ft. long.

Heat Pump

Performance of Water Source Heat Pumps. In Pacific Northwest. J. D. Krocker. **For Office Building**

in Southwest. F. L. McFadden, Jr. *ASHRAE J. 1,* 78 (1959) May (6 pp.)

Essentially a heat pump is a refrigerant compressor which converts energy for either heating or cooling. However, reference generally to heat pumps seems to imply inclusion within a system of the heat source, the mechanical system which distributes and collects heat in a building or in an application, and the heat sink. In discussing performance, the portion of the system external to the actual heat pump will determine to a large extent the degree of effectiveness or the degree of conversion and effective use of energy. Article describes two approaches to water source units in the western U.S.

Space Heaters

Temperature Drop Is an Important Design Yardstick in Choosing Most Economical Hot Water Heating Systems. G. F. Carlson. *Heating, Piping & Air Conditioning 31,* 106 (1959) May (4 pp.)

Low, intermediate and high temperature hot water heating system operating temperatures and design temperature drops have a definite bearing on the selection of the most economical design for each application. Author relates how increased temperature drop can decrease the pipe size, what factors to consider, and how control of the systems becomes more critical as the temperature is increased.

Water Heaters

Water Heating for Commercial Kitchens. T. Z. Dunn, R. N. Spear, B. E. Twigg and D. Williams. *Air Conditioning, Heating and Ventilating 56,* 69 (1959) May (15 pp.)

Guide to the proper sizing, selection and installation of gas-fired water heating systems for all types of restaurants and cafeterias. Article discusses need for ample quantities of both 180° and 140° F water to meet modern standards of sanitation; various types of dishwashing equipment are described, including arrangements and sizes of water heating apparatus. Basic information is furnished on water and gas piping, venting and required clearances.

Burners

Parallel Slot Gas Burner. R. R. Taylor (assigned to Fraser & Johnston Co.) U.S. 2,884,998 (1959) May 5.

Improved longitudinal slotted port gas burner for house furnaces is claimed which is made of sheet metal. Mixing chamber is formed by bending a sheet to form an approximately cylindrical chamber, with sheet edges bent to form flat walls which are parallel to each other. Plane parallel strips are disposed in the space between the flat walls, spaced apart by temporary separators and fastened with multiple screws through walls and strips to form long parallel rectangular slot ports, practically free of obstruction to gas flow, after the separator jig is removed.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Automatic Data Acquisition and Logging for Gas Dispatching. T. C. Schroeder. New York: A.G.A. Operating Section Proceedings; Paper No. DMC-59-13 (1959) Apr.

Paper discusses various methods of automatically acquiring operational data and recording these data, which are presently available, for integration into the gas dispatching operation, and to present those factors which must be considered if optimum results are to be achieved in using automatic data acquisition and logging equipment. Included in its scope are 1) statement of the problem; 2) various methods of acquiring information automatically; 3) methods of automatic presentation of data logging; 4) effect of existing installation on the design of the automatic acquisition and logging facility; 5) discussion of reliability and security of systems; 6) discussion of the economics of systems application, and 7) word about control in such systems.

Infrared Analyzer Controls Absorber. G. M. Hicks and D. D. Livingstone. *Petrol. Refiner 38,* 183 (1959) May (4 pp.)

Using an infrared analyzer has increased efficiency of a demethanizing absorber at Polymer Corp.'s Sarnia (Ont.) plant. Analyzer set-up increases ethylene recovery and minimizes methane absorption. It is used to control heat input to the reboiler. Although the automatic nondispersive analyzer is more expensive than ordinary environmental control instruments and requires more maintenance, it can be used to provide satisfactory control in systems where no other instrument is practical.

Computers

Computing Convergence Pressure. E. I. Organick and B. J. Hollingsworth. *Petrol. Refiner 38,* 172 (1959) May (2 pp.)

Digital computers may be programmed to select the proper convergence pressure, P_k, in the course of a flash calculation or other vapor-liquid equilibrium determination using the Hadden method. The NGAA K-Committee points out the advisability of checking P_k, a refinement procedure, whenever P/P_k exceeds

0.4. Block diagrams and equations for programming the computer are offered to permit automatic checking of the assumed P_k when desired.

Deethanizer Performance Evaluation. A. J. Gully. *Petrol. Eng. 31,* C-34 (1959) May (8 pp.)

Application of rigorous computational methods, which is possible with high speed computers, does not necessarily produce reliable answers to process engineering questions. Confidence in predictions arrived at through engineering calculations can only result from the combination of sound methods and accurate basic data. Machine computations are becoming more and more prevalent in fractionator calculations. A reevaluation of the available data on vapor-liquid equilibria, enthalpy and tray efficiency in the light of recent advances in computational methods seems desirable.

Potential Computer Applications to Gas Operations. W. A. Shipman and L. J. Rankine. New York: A.G.A. Operating Section Proceedings; Paper No. GSTS-59-7 (1959) May; **Potential Computer Applications to Gas Dispatching and Operation.** *Gas Age 123,* 22 (1959) May 28 (7 pp.)

Achievements to date in use of digital computers in advance scheduling of system gas supply are but a few steps toward ultimate automation of system. What is needed is a mutual understanding between utility men, research men and computer manufacturers of the practicalities of the problems involved.

Gas Turbines

Gas Turbine Applications in Gasoline Plants. C. R. Apitz. *Petrol. Eng. 31,* C-20 (1959) May (6 pp.)

Space, time and money saving methods for utilizing various characteristics of the increasingly popular gas turbine. Turbine described is an open cycle, combustion gas turbine, rated at 1265 bhp at 80° F ambient temperature and sea level.

Gas Turbine Powers Drilling Rig. *Petrol. Week 8,* 28 (1959) June 5.

Gas turbine engine of the same type used to power turboprop airplanes has made an experimental debut in the drilling industry. Drawback: High cost (around $50,000). Advantages: Smaller size and weight. With a weight of 2859 lb and a length of only 98 in., the turbine weighs far less and requires less space than the power source it replaces. It is air-cooled, an important factor in both desert and Arctic areas. Availability of exhaust heat for cold-weather work is still another advantage.

Small Gas Turbine Machines for Mobile Air Conditioning. H. K. Ziebarth. *ASHRAE J. 1,* 62 (1959) May (5 pp.)

Either as prime mover or actuator, the turbomachine is effective within a fraction of the weight and installation space of reciprocating or positive displacement machines. Article discusses some recent turbomachine design applications as key components of aircraft, ship, submarine, railroad and automotive air conditioning and refrigeration systems.

Studies in the Chemistry of the Operation of Solid-Fuel-Fired Gas Turbines. Part 4. Examination of Ash Samples from an Open-Cycle Gas Turbine after Running on Pulverized Peat. J. A. Waddams and J. C. Wright. *J. Inst. Fuel 32,* 241 (1959) May (5 pp.)

Experimental work on ash samples taken from a medium-power open-cycle peat-fired gas turbine after various running trials is described. Characteristics of the ash deposits were established and showed some relationship to engine operating conditions. It was found that the nature of the deposits formed was largely dependent on the type of peat from which they were derived, but the quantity of ash deposited by a given amount of a single peat was dependent on combustion temperature. Reactions which certain constituents of the peat ash undergo before deposition takes place originate in the flame. High rates of deposition are probably associated with ashes of high sulfate and chloride content.

Studies in the Chemistry of the Operation of Solid-Fuel-Fired Gas Turbines. Part 5. Dry Corrosion Aspects of Peat-Ash Deposition. J. A. Waddams and J. C. Wright. *J. Inst. Fuel 32,* 246 (1959) May (5 pp.)

Susceptibility of Nimonic 80A to dry corrosion at operating temperatures by the components of peat ashes deposited in a peat-fired open-cycle gas turbine has been investigated. Nimonic 80A resists dry corrosion by most of the components of the ashes but it is possible for Nimonic 80A turbine blades to suffer damage if the ashes striking them contain relatively large amounts of sulfates and chlorides. This reaction has been investigated and a theory is proposed to account for the type of dry corrosion encountered. Protective nature of the chromic oxide film is destroyed and the underlying metal is subject to an attack by sulfur derived from sulfates in the peat ash.

Studies in the Chemistry of the Operation of Solid-Fuel-Fired Gas Turbines. Part 6. A Proposed Mechanism for the Deposition and Bonding of Ashes in an Open-Cycle Peat-Fired Gas Turbine. J. A. Waddams and J. C. Wright. *J. Inst. Fuel 32,* 249 (1959) May (4 pp.)

Conclusions of five previous papers of this series (see also *Gas Abstracts 15,* 166-7) are combined in

this article. From a discussion based on these, the "life-cycle" of ash particles in a peat-fired gas turbine can be predicted. Ensuing problems of erosion, corrosion and ash deposition in the turbine are outlined and explanations of these phenomena are presented. It seems possible that erosion is an unusual condition in the working of the turbine and can be controlled more easily than corrosion and ash deposition which are more fundamental problems. Most profitable line of investigation for final control of corrosion and deposition appears to lie in combustion-chamber design and control of the intensity of combustion.

Metering

True Mass Flowmeter Measures Fluids Directly in Pounds. *Gas 35,* 82 (1959) June (2 pp.)

Simple, low-maintenance device which precisely measures the weight of flowing fluids with high accuracy over wide ranges of flow rate, pressure, temperature and density without additional measurements and corrections for these variables will be available early in 1960. Flowmeter is compatible with automation, being designed to emit a series of electrical pulses, each representing a given weight of flow. This signal is designed to operate remote recording, dispatching and accounting systems. Device will measure not only natural gas but also naphtha, gasoline, LPG and other hydrocarbon liquids, refinery gas, oxygen, nitrogen, etc. Development work is continuing to adapt the mass flowmeter to measurement of other gases and liquids including hydrogen and helium as well as high temperature, corrosive and cryogenic fluids — steam acids and liquid oxygen, for example.

Pilot Plants

Small Semiautomatic Pilot Plants. W. M. Miller. *Oil Gas J. 57,* 135 (1959) June 1 (9 pp.)

Four small semiautomatic pilot plants and the catalyst-activity decline testing unit operated at Tidewater Delaware and Avon plants furnish the data used in guiding refinery operations. To reduce the cost of operating these units, they were made small in size and were designed to run with a minimum of attention. Two of the units are believed to be unique in the oil industry in that they run unattended 16 hours a day. To accomplish this type of operation, more than the usual amount of automatic controls and safety devices found in most pilot plants are used. In describing these small pilot plants and catalyst-activity decline testing unit, special emphasis is placed on their automatic features.

Pumps

Sonic Pump Makes Its Debut. F. B. Taylor. *Independent Petrol. Assoc. Monthly 30,* 26 (1959) May (3 pp.)

Unlike conventional pumping units, the sonic pumps makes use of no jack or beam, sucker rods, bottom hole pump, nor does it pump through tubing used as sucker rods. Instead, the unit consists of a drive shaft to connect the prime mover to the oscillator which imposes mechanical impulses on the tubing string, a spring or air-mount from which the tubing is suspended, check valves within the tubing string, and tubing guides of the friction-hold type.

Temperature Measurement

Apparatus and Technique. A Graphite/Graphite Thermocouple for High Temperatures. A. R. Ubbelhode, L. C. F. Blackman and P. H. Dundas. *Chem. & Ind.,* 595 (1959) May 9 (2 pp.)

By forming a hot junction between purified highly oriented (on a-axis) pyrolytic graphite as a central rod and a polycrystalline graphite heat-treated at 2500° C as an outer sheath, a stable thermocouple is formed which reproducibly yields 36 mv at 2400° C. Cold junctions are water-cooled brass tubes and the unit requires protection by inert gas.

Some Recent Instruments for Measuring Gas Temperatures and Heat Flow. G. G. Thurlow. *BCURA Monthly Bull. 23,* 129 (1959) Apr. (9 pp.)

Article deals with some recent developments in instruments used to study heat transfer from flames. No attempt has been made to be comprehensive; the instruments described are limited to those of which the reviewer has some direct knowledge. Some of the instruments have been developed within the B.C.U.R.A. and others are the outcome of work carried out, often jointly, by the British Iron and Steel Research Association, the United Steel Cos., Ltd., Land Pyrometers, Ltd., the Royal Netherlands Steel Co. and, in particular, the International Flame Research Foundation. Instruments discussed include suction pyrometers, Venturi pneumatic pyrometers, heat flow meters and radiation meters.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Cathodic Protection Requirements of Plastic Coated Pipe. T. E. Brady. *Gas 35,* 65 (1959) June (3 pp.)

Western Kentucky Gas Co. distributes natural gas to 57 communities in western Kentucky. The over

1000 miles of main in the company's system range in age from cast iron pipe installed in the late 1800's to mill coated steel pipe recently installed. Present standard of coating is 4/32 in. of coal tar with a glass and felt wrap. All pipe is cathodically protected as it is installed. To date, over 500 miles of the system has been cathodically protected. Company is continually testing new materials, and article describes its experiences with plastic coating known commercially as X-Tru-Coat which, after about eight months of testing, still shows practically zero conductance.

Coatings

Evaluating the Economy of Reconditioning and Coating Underground Steel Pipe. G. M. Pemberton. *Corrosion 15,* 279t (1959) May (3 pp.)

By carefully selecting pipe for reconditioning, and accurately determining the time required for spot welding, the cost per foot for reconditioning an underground bare steel gas pipe line can be predicted. A method is developed to show that the economy of the total operation is related to this and other easily determined costs. A description of welding and wax coating methods used for an actual job is included with photographs, charts and graphs.

Pipeline Coatings . . . Present and Future. N. T. Shideler, W. J. Kretschmer and D. A. Tefankjian. New York: A.G.A. Operating Section Proceedings; (1959) Apr.; *Gas Age 123,* 27 (1959) May 14 (3 pp.)

Today's coating requirements are far more demanding than they were a few years ago. These requirements are: 1) Permanent low water absorption and/or low moisture vapor transmission; 2) permanent high electrical resistance; 3) non-flow characteristics at low or high temperatures; 4) sufficient hardness to be unaffected by soil stress or punctured by stones or debris in the trench or back fill; 5) tight bond to pipe; 6) sufficient flexibility for bending coated pipe without damage to the coating; 7) easily applied and quick setting; 8) easily handled without damage; 9) easily applied to joints, flanges and fittings, and 10) no need for wrappers, padding rock shield, etc. Research being conducted on synthetics including the coal tar-epoxy resin coatings will eventually lead to the development of an easily applied, synthetic coating that will be more nearly ideal for all phases of pipeline work.

Synthetic Pipeline Coatings Promising. M. J. Dabney, O. C. Slotterbeck and D. F. Koenecke. *Oil Gas J. 57,* 160 (1959) June 8 (4 pp.)

Several gas and petroleum companies in cooperation with resin and paint manufacturers have been evaluating new resin coatings in the laboratory and in field tests for underground pipeline use. Studies are being conducted on epoxy and/or epoxy-bituminous combinations and on polyethylene and vinyl tapes for improved coatings. Results to date indicate that: 1) Properties of thin-film synthetic coatings, when properly selected, meet the necessary requirements for pipeline protection and may be competitive with the materials presently used; 2) it is important to use the optimum cure which in many instances is at elevated temperatures; 3) formulation of the coating is essential for the best and optimum life under cathodic conditions as well as general corrosion resistance, and 4) revolutionary application and curing methods may be required to make thin-film synthetic coatings competitive with the hot-applied bituminous or asphalt types which are the standards of today.

Corrosion

New Plastic Coupler Helps Solve Service Line Insulating Problems. *Am. Gas J. 186,* 38 (1959) June.

Easily installed plastic compression-type coupling has been developed to prevent corrosion caused by flow of stray currents in gas service connections. It is an insulation connection made of high-impact unplasticized polyvinyl chloride for use in isolating gas service pipe from customer piping. Fitting has rubber gaskets that grip the metal pipe ends when the coupling is tightened and a sliding "spacer ring" of PVC that is inserted to keep the pipe ends from making contact with each other inside the coupler.

Prevention of Corrosion of Stored Pipe and Laboratory Evaluation of Internal Pipe Coatings for Natural Gas Service. G. G. Wilson. New York: A.G.A. Operating Section Proceedings; Paper No. GSTS-59-11 (1959) May.

Literature and industrial survey of oil and gas industry experience with internally coated pipe, methods used to apply internal pipe coatings, and coating materials, suitable for the internal coating of pipe for natural gas service, was initiated at the Institute of Gas Technology in 1955. It was continued through 1957 for laboratory screening tests of the suitability of 27 different types of coating systems for natural gas pipeline service. Information presented on gas industry experience with method of preventing corrosion of stored pipe was obtained by circulation of a questionnaire to 21 transmission and 38 distribution companies, and includes data on the extent of the problem, as well as industry experience with internal coatings, wetting oil and endcaps to prevent corrosion. Coating properties tests were adhesion, impact resistance, abrasion resistance, surface roughness, flexibility, hardness, ability to maintain desired

properties within temperature limits from 15°-130°F, ability to withstand cyclic decompression from pressures of 1000 psig without blistering or flaking, reaction to temperatures encountered during welding operations, and resistance to partial immersion at 130°F in lubricating oil, natural gasoline, saturated salt solution, a typical treating agent used to remove acid gases, and a water solution of acid gases. Results of these tests are presented in the form of ratings of the relative suitability of the coatings for three different types of natural gas pipeline service.

Inhibitors

Acetylenic Alcohol-Inhibited Pickling Bath as a Pretreatment Prior to Lining Steel Pipe. K. N. Edwards, L. J. Nowacki and E. R. Mueller. *Corrosion 15,* 275t (1959) May (4 pp.)

Test results on steel panels confirm that acetylenic alcohols when used as inhibitors in pickling baths provide a substrate which will increase the corrosion inhibition of epoxy-phenolic systems under extreme immersion conditions. It was found that this substrate under test conditions provided protection equal to or superior to that provided by lightweight zinc phosphate pretreatment. Certain postulated reactions are offered to explain this phenomenon. It is possible that the mechanism is tied in with acid and hydrogen embrittlement inhibitive properties. Data reported include the effect of differing metal surface treatments on the corrosion-resisting properties of epoxy-phenolic coating systems, the effect of lead ion on the corrosion resistance of pickled coated panels, and results of hydrogen embrittlement bend test for acetylenic alcohol concentration. Study was conducted primarily to improve the corrosion resistance of coated steel pipe carrying hot potable water.

Corrosion Prevention in Tankers and Storage Tanks by Fogging or Flotation with an Inhibitor Solution. J. C. D. Oosterhout, M. E. Stanley and W. S. Quimby. *Corrosion 15,* 241t (1959) May (4 pp.)

Two methods for reducing internal corrosion of tankers are described. These methods involve 1) flotation of an oil soluble inhibitor on ballast water to coat the internal surfaces of the tanks, and 2) fogging of inhibitor into empty tanks using an inert dispersant. Both methods were tested in the laboratory as well as in the field and were found to produce satisfactory results, particularly on underdeck surfaces. Data reported include effect of dry gas fogging versus wet gas fogging, effect of time in fogging oil soluble inhibitor with steam, and effect of oil soluble and water dispensable inhibitor on steel surfaces wetted with gasoline and/or sea water.

Follow New Startup Procedure to . . . Reduce Cooling System Corrosion. C. T. Palen. *Petrol. Refiner 38,* 239 (1959) May (4 pp.)

Recently improvements in corrosion inhibitors and *p*H control systems have led to the increased use of steel tubes for condensers and coolers in industrial cooling water systems. The satisfactory application of steel for this service in place of the more expensive copper alloys results in substantial savings in plant capital investment. Also, in many cases steel tubes permit the use of ammonia for the neutralization of acidic materials present in the process stream being cooled, while brass tubes are subject to attack by ammonia.

12. ANALYTICAL METHODS AND TESTS

Carbon Dioxide

Spectrophotometric Titration of Parts Per Million of Carbon Dioxide in Gases. J. W. Loveland, R. W. Adams, H. H. King, Jr., F. A. Nowak and L. J. Cali. *Anal. Chem. 31,* 1008 (1959) June (3 pp.)

In the spectrophotometric titration of traces of carbon dioxide in a gas stream, the carbon dioxide is absorbed in dilute sodium hydroxide and the excess caustic is back-titrated with dilute hydrochloric acid. The titration is followed at 555 $m\mu$ on spectrophotometer using phenolphthalein as an indicator. A special absorption bulb gives a complete recovery of all carbon dioxide up to gas flow rates of 100 cm^3/min. Sensitivity is about 1 ppm of carbon dioxide for 20 l of gas. Accuracy is about 1 ppm and the repeatability standard deviation is to 0.4 ppm in the 1-10 ppm range. Other acidic gases interfere.

Chromatography

Elimination of Preliminary Depentanization of Gasoline Prior to Hydrocarbon-Type Analysis by Mass Spectrometry. H. E. Howard and W. C. Ferguson. *Anal. Chem. 31,* 1048 (1959) June (2 pp.)

Usual mass spectrometric procedure for the determination of hydrocarbon types in nonolefinic gasolines containing C_5 and lighter hydrocarbons is encumbered by a preliminary distillation to remove the C_5 and lighter hydrocarbons. Now, however, the need for preliminary depentanization can be eliminated by the use of gas chromatography in conjunction with the mass spectrometric analysis. C_5 and lighter hydrocarbons are determined by any gas chromatographic method which expresses results in liquid volume per cent. On the basis of these data, the mass spectrum of the total gasoline is mathe-

matically corrected for the presence of C_5 and lighter hydrocarbons. No loss of accuracy is experienced, and costly distillation time, 2-4 hours, is eliminated.

Gas Chromatographic Analysis of Hydrocarbon Streams from Butane Dehydrogenation. T. A. McKenna, Jr. and J. A. Idleman. *Anal. Chem. 31,* 1021 (1959) June (3 pp.)

Gas-solid and gas-liquid chromatography have been investigated in order to provide a faster, more specific analytical technique for multicomponent stream analysis as typically found in butadiene-producing facilities. Procedures are described for the separation and analysis of all hydrocarbon gases from hydrogen through C_4 using columns at room temperature. Separations are sufficiently complete that peak height, half band width calculations can be made on all components without resorting to chromatographic calibration factors. Variations in column parameters are evaluated. The analytical scheme presented fills a void that has existed in gas chromatography for laboratories engaged in the analysis of light hydrocarbons. Methods eliminate the need for ice baths and attendant equipment, and are rapid, definitive and capable of accurate determinations with a minimum of instrumentation.

Gas Chromatographic Analysis of Various Mixtures of Compounds Containing Chlorine. G. W. Warren, L. J. Priestley, Jr., J. F. Haskin and V. A. Yarborough. *Anal Chem 31,* 1013 (1959) June (4 pp)

Gas chromatographic methods were developed for the analysis of several mixtures of chlorine-containing compounds from laboratory process studies. A chromatographic method was developed for the analysis of unrefined 1,2-dichloroethane, refined carbon tetrachloride, and chloroform because other instrumental and/or chemical techniques were not adequate. Lower detection limits for chloroform, trichloroethylene, and tetrachloroethylene in carbon tetrachloride are 200, 200, and 500 ppm, respectively. Lower detection limits for dichloromethane, 1,1-dichloroethane, 1,2-dichloroethane, and carbon tetrachloride in chloroform are 50, 200, 400, and 200 ppm, respectively. The chromatographic method for the analysis of refined 1-chlorobutane requires 12 minutes; the chemical method takes 40 minutes.

Gas Analysis

Evaluation of Absorption Sampling Devices. L. R. Roberts and H. C. McKee. *J. Air Pollution Control Assoc. 9,* 51 (1959) May (3 pp.)

As a first step in the development of new types of sampling equipment, the operating characteristics of samplers now available were determined. Operating conditions were deliberately extended well beyond the intended range in order to establish limits for the present samplers. Article presents data obtained in evaluating samplers now available. A subsequent article will cover results being obtained in development and design of new types of samplers.

Poisonous Action and Detection of Injurious Gases and Vapors in Mining Operations. K. W. Hetzel. *Brennstoff-Chemie 40,* 115 (1959) Apr. 22 (8 pp. German text.)

Origin and chemical proportions of principal poisonous gases and vapors occurring in mining operations and their toxicology is first reviewed. Present techniques in gas trace testing and the industrially used apparatus with appropriate reagent tubes are listed, which, in most cases, give a specific detection for a particular gas and make possible in practice a sufficiently semi-quantitative determination of the gas. Medical and toxicological aspects of industrial chemicals are emphasized.

Selection of Components for Gas Analyzer Sampling Systems. J. L. Cotter and L. E. Maley. *Chem. Eng. Progress 55,* 122 (1959) May (3 pp.)

Selection of components of gas sampling systems can be as important to the performance of a gas analyzer as the analyzer itself. In some instances, the cost of developing a system may equal or exceed the cost of the analyzer. In other instances, unnecessarily expensive components may be used because the availability of suitable, less-expensive components is not known. Attempt has been made to evaluate significant characteristics of some of the commercially available filters, pressure regulators, valves, condensate traps and sample conditioners with respect to advantages, limitations and costs.

Use of Combustible Gas Indicators. N. W. Hartz. *Nat. Fire Protect. Assoc. Quarterly 52,* 357 (1959) Apr. (9 pp.)

Present, almost universal, method of detecting and measuring combustible gases and vapors in air has been in use for almost 30 years. Although the principle of measurement has remained the same, refinements and variations in design have been made as utilization has grown to more than 100,000 combustible gas analyzers in use today. Author attempts to show some of the many variations and adaptations that have been made to conventional combustible gas indicators to better fit them to the applications which have developed for these instruments. Included are hot wire indicators with applications and limitations, dual purpose indicator and continuous combustible gas indicators.

Hydrocarbons

Monitoring Trace Hydrocarbons in Air by Catalytic Oxidation and Nondispersive Infrared Analysis. E. J. Rosenbaum, R. W. Adams and H. H. King, Jr. *Anal. Chem 31,* 1006 (1959) June (3 pp)

Concentration of hydrocarbons in air at the low ppm level is continuously determined by combining catalytic oxidation with a nondispersive infrared analyzer to determine the resulting carbon dioxide. Known blends of methane in oxygen-nitrogen mixtures are used to test catalyst activity and calibrate the combination of catalyst and analyzer. The limit of detectability is below 1 ppm, and the calibration curves are linear up to a concentration of 300 ppm. Equipment has operated under plant conditions for over two years with no loss of catalytic activity and only routine maintenance.

Hydrogen Sulfide

The Application Area of the Different Methods for Determination of Hydrogen Sulfide in Coke Oven Gas. P. Michaelis. *Brennstoff-Chemie 40,* 104 (1959) Apr. 22 (9 pp. German text.)

Exact determination of hydrogen sulfide in coke oven gas must be accomplished with consideration for the gas composition and the uniformity of sampling. For solving this problem, three known methods were used which, by their different kinds of chemical combination and reactions to H_2S, complement each other in their application ranges.

Mercaptans

Determination of Alkanethiols in Hydrocarbons with Silver Ion and Dithizone. R. K. Kunkel, J. E. Buckley and G. Gorin. *Anal. Chem. 31,* 1098 (1959) June (2 pp.)

Simple and precise methods are described for the titrimetric and the colorimetric determination of alkanethiols in hydrocarbons. Samples (0.01-1 mmole) are titrated with silver ion in an ammoniacal alcoholic medium, using ammonium dithizonate as indicator. A sharp color change from orange to red is observed at the end point. The precision is to about 0.2%. Smaller samples (0.002-0.08 mmole) are analyzed by adding them to a carbon tetrachloride solution of silver dithizonate in a spectrophotometer cell. After five minutes, the absorption due to liberated dithizone is read at 615 mμ. A correction is made for the dilution caused by addition of the sample, and the result is compared to a standard curve. The accuracy is about 2%.

Methane

Determination of Trace Amounts of Methane in Air. D. M. G. Lawrey and C. C. Cerato. *Anal. Chem. 31,* 1011 (1959) June (2 pp)

From 1-6000 ppm by volume of methane in air can be determined by gas chromatography. A high sensitivity amplifier and a splitter column packed with a partially deactivated charcoal are used to gain the desired sensitivity and resolution. Results on 11 known blends ranging from 15-6000 ppm of methane gave an average deviation of $\pm 11\%$. Repeatability standard deviation was ± 2.37 ppm at the 30 ppm level.

Oxygen

The Direct Determination of Oxygen and Its Application in Fuel Analysis. W. Radmacher and A. Hoverath. *Brennstoff-Chemie 40,* 97 (1959) Apr. 22 (8 pp. German text.)

Usually the oxygen of the organic substance of coal is not determined by direct methods in the elementary analysis. Here the associated mineral components cause trouble in this determination. Using the Schütze-Unterzaucher method and by demineralizing the coal, a direct accurate method was developed for the determination of oxygen in coal. Application of this method, especially in the area of alteration of coal properties by oxidation, is described with many examples.

Spectography

The Longest Wavelength Band in the Electronic Spectra of Polycyclic Aromatic Hydroarbons for Analytical Use. C. Karr, Jr. *App. Spectroscopy 13,* 15 (1959) No. 1 (11 pp.)

Table is presented listing 408 polycyclic aromatic hydrocarbons, with three or more aromatic rings, according to increasing values in millimicrons of the longest wavelength absorption band. Structural formulas, the values in millimicrons of additional absorption bands, solvents and literature references partly through 1958 are also given. Procedure is recommended for utilization of this table in the spectrophotometric analysis of samples, such as those obtained in fractionation by elution chromatography.

13. BASIC SCIENCE

Absorption

Method of Calculations for the Absorption Accompanied with Heat Liberation. T. Mizushina, J. Oishi and N. Hashimoto. *Chem. Eng. Sci. 10,* 31 (1959) Nos. 1/2 (6 pp.)

Article describes method of calculation for the absorption accompanied with heat liberation in counter-

current-type liquid-gas contactors. Enthalpy of mixed gas is defined in terms of absorption heat, and at low concentrations of solute gas and solvent vapor in mixed enthalpy of mixed gas derived from the previously mentioned enthalpy. By using the diagram of equilibrium conditions and the diagrams which show the relations among the enthalpy, modified enthalpy and temperature of mixed gas, the concentration of solute in mixed gas, the temperature of liquid and the concentration of solute in liquid, the change of condition of gas can be traced through the apparatus. The required area for the absorption can be easily calculated by this method without using the complicated method of successive analytical calculation.

Adsorption

Adsorption of Mixed Vapors. H. N. Reeds and K. Kammermeyer. *Ind. Eng. Chem. 51,* 707 (1959) May (3 pp.)

Investigations of separations of vapor mixtures with microporous media indicated that selective adsorption of vapor constituents had a pronounced effect on the separation. Adsorption studies were made with the system benzene-methanol on Vycor porous glass as the adsorbent. Selective adsorption was definitely established together with the existence of an adsorptive azeotrope. The azeotropic composition shifts with temperature or pressure in analogy to vapor-liquid azeotropes. Existence of adsorption azeotropes, not yet reported, is of importance in all separation processes which involve adsorption operations.

Carbon Monoxide

Experimental Verification of Theoretical Relations between Total Gas Absorptivities and Total Gas Emissivities for CO. U. P. Oppenheim. *J. Appl. Phys. 30,* 803 (1959) June (5 pp.)

Experimental study has been conducted for the purpose of verifying theoretical predictions concerning the relations between total absorptivities and total emissivities for transparent gases. Experimental conditions have been designed in such a way as to permit a direct check of theoretical relations derived for 1) nonoverlapping dispersion lines and 2) spectral lines with sufficient pressure broadening to permit neglect of the rotational fine structure. A comparison between the emissivities derived from absorptivity measurements and emissivities calculated from the spectroscopic constants of CO shows a good agreement (within 20% for most of the temperature range). Apparatus for the measurement of total gas absorptivities is described. Results for total absorptivities of carbon monoxide measured at temperatures between 300 and 500° K are given and total emissivities have been calculated in the temperature range of 300-1600° K. Range of total gas pressure is 0-515 psia.

Density

Pressure-Temperature-Density Relations of Pure Liquids. A. W. Francis. *Chem. Eng. Sci. 10,* 37 (1959) Nos. 1/2 (12 pp.)

Simple equations were published recently (see *Gas Abstracts 13,* 274) for 44 hydrocarbons relating saturated liquid densities with temperature over wide ranges. Another equation showed a simple relation between liquid density and slopes of isochors, $(dP/dt)_V$, for compression of 27 hydrocarbons and hydrogen. The same forms of equations have now been found applicable to non-hydrocarbons over even wider ranges and with deviations hardly greater than uncertainties. In this article, saturated densities of liquids are expressed as $D_s = A - Bt - C/(E - t)$ over almost the entire ranges for which data are available. The constants are presented for 130 pure substances. Liquid density under high pressure can be calculated from saturated density by the equation, $\log (dP/dt)_V = KD - F$, whose constants are tabulated for most of the same liquids.

Distillation

Report of the Distillation Panel Recommending Some Basic Researches. *Chem. & Ind.* 585 (1959) May 9 (10 pp.)

Inquiries by the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers Association showed that the major research interest was in distillation. Also the existing knowledge of distillation was inadequate. The ABCM recommended that the survey cover the field of distillation in greater detail, and in the following aspects: 1) Extent of published information; 2) special knowledge held by firms in the industry, and 3) gaps in existing knowledge. It was decided an expert panel be established for publication of a handbook on the present state of knowledge and to recommend research to fill gaps. Report of this panel's activities is given.

Fluid Flow

Calculation of the Laminar Boundary Layer in Compressible Flow with Pressure Gradient along an Insulated Wall. B. LeFur. *C. R. Acad. Sci. Paris 246,* 546 (1959) Jan (4 pp. French text.) (From *Appl. Mech. Rev. 12,* 340 (1959) May.)

Problem of the compressible boundary-layer flow with variable density ρ and viscosity μ and a Prandtl number $Pr = 1$ is reduced to the problem of a boundary-layer flow with constant ρ and μ

by a transformation which is a generalization of the Howarth-Stewartson transformation. The new transformation involves the recovery factor r. By this transformation the momentum equation for compressible boundary-layer flow can be reduced to the momentum equation for incompressible flow. The temperature profile is assumed to be a fourth-order polynomial in y (coordinate normal to the wall in the incompressible problem). Author states that for the flat plate flow his results agree with those of Chapman and Rubesin. No comment is made about the determination of r for the general case (pressure distribution along the wall).

Irmgard Flugge-Lotz, USA

Fractionation

Control by Temperature Difference? W. O. Webber. *Petrol. Refiner 38,* 187 (1959) May (5 pp.)

Article presents some limitations and some areas of applicability of temperature difference control. Several years ago temperature difference control was tried on butane splitters at Humble Oil & Refining Co.'s Baytown (Texas) refinery for the separation of normal and isobutane, in the absence of other components such as pentanes and heavier. After solving certain initial problems, this method of control proved reliable, and, in fact, resulted in the release of a plant infrared analyzer. Then in early 1956, the light ends fractionation columns were rearranged in order to attain a more economic sequence of operations. After this revision, all of the butane separating operations were carried out in alkylate deisobutanizers in the presence of other components. With this operation, temperature difference control became unsatisfactory. Thus, temperature difference control is seen to have limited application.

A Horizontal Fractionating Device. M. Markels, Jr. and T. D. Drew. *Ind. Eng. Chem. 51,* 619 (1959) May (6 pp.)

Horizontal fractionator has been studied in which vapor flows horizontally and the liquid, flowing generally countercurrent to the vapor, is pumped over a series of cross-flow stages. Stages of three types of wire mesh and one of expanded-metal mesh have been tested for capacity, pressure drop, entrainment and efficiency. Humidification measured the vapor phase efficiency, and oxygen desorption the liquid phase efficiency. The better contactors had Murphree efficiencies equal to bubble-cap and sieve-plate results, but operated at lower pressure drop at the same capacity.

For Multicomponents . . . Rigorous Distillation Method. R. G. Graven. *Petrol. Refiner 38,* 209 (1959) May (8 pp.)

Completely rigorous, analytical distillation calculation method is described which results in rapid convergence to a final solution with a minimum of trial and error calculation Method is applicable to all tower arrangements including absorbers, strippers, and fractionating towers with multiple feeds, sidedraws and other modifications

Heat Transfer

Find Heat Losses Graphically. C. R. Kise. *Petrol. Refiner 38,* 227 (1959) May (10 pp.)

Calculation of heat transmission through an insulating material is very simple when the temperature of both the hot and cold faces is known. In actual practice, however, the problem usually requires a designer to estimate the saving in heat that can be made by applying insulation to a hot object, and the temperature of the external surface is unknown. It is then necessary to assume temperature values for the external surface, calculate the heat transmission through the insulation, and balance this against the heat loss from the surface. A series of simple graphs and nomographs is presented which will permit the designer to perform heat loss and insulation calculations simply, with a minimum of time and effort and with excellent over-all accuracy.

Recent Developments in Convective Heat Transfer. R. H. Saversky. *ARS J. 29,* 325 (1959) May (7 pp.)

Article discusses transpiration and film cooling, heat transfer in rough tubes, nucleate boiling, heat transfer to fluids near the critical point, and flow with internal heat generation. Reference is made to some of the principal sources of information. Although the given bibliography is relatively extensive, it cannot be considered complete.

Particle Size

Measuring Drop Size of Hollow Cone Sprays. H. Binark and W. E. Ranz. *Ind. Eng. Chem. 51,* 701 (1959) May (2 pp)

During a general investigation of induced air flows in sprays it was discovered that air flow does not follow the spray in one special case. This fact suggested a simple test method for determining drop size distribution. For hollow cone sprays, where induced air flow crosses the drop trajectories, an apparent drop size distributon can be obtained by considering the stopping distance of various portions of the liquid flux. A simple procedure was developed to demonstrate the relationship between drop size and liquid flux distribution. Initial applications indicate that the new method gives proper drop size distributions in a small fraction of the time required by tedious sampling and counting methods.

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